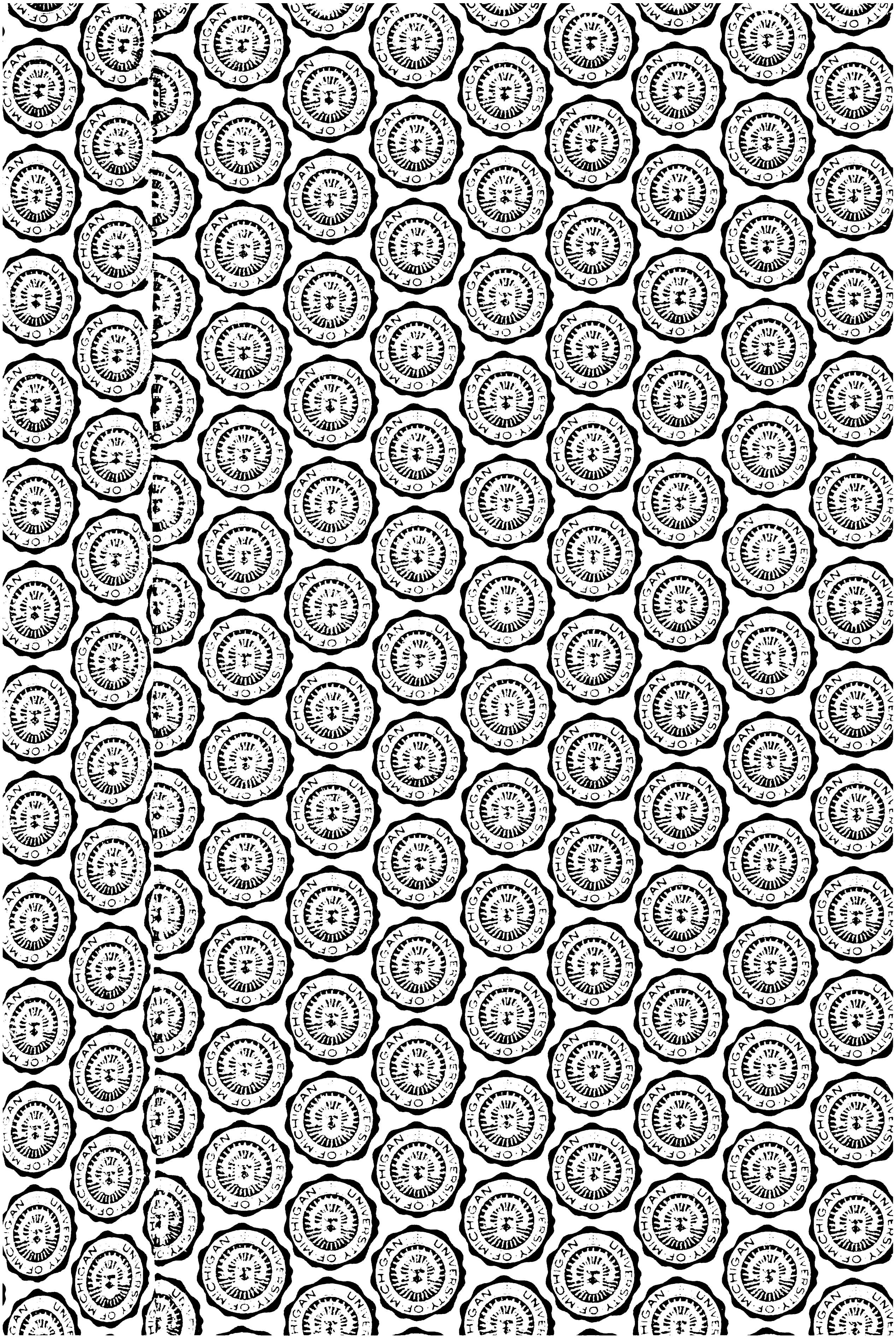
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SCIENCE

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MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

RESEARCH[1]

THE university is the natural home for research. The development of research institutes, except of those that have been built up around a great genius, and during the period of the active life of such a man, is apt, in the long run, to be more of a menace than help to the work of investigation. In a way the establishment of these institutes is a measure of university inefficiency. They mean that the universities have failed to rise to their full possibilities as centers of mental activity.

Research institutes lack the current of successive generations of students from which to pick out the right minds and to draw new blood. They do not feel the internal heave and struggle, the pressure that comes from association with the great turbulent mental forces that accompany youth. There is too much pressure for evident results, too much discipline of research minds to achieve a big effect. Just at the period when those who have the proper training and ability and the love for investigation that must go with success in discovering new things, many of the workers in research institutes and departments are compelled to work on the problems of some one else. This is valuable and satisfactory up to a certain point, but beyond that it means sterilization of the best that is in the men; it means putting aside their own projects, perhaps permanently. It is a serious thing for any one full of expanding ideas to be made a "scientific bootblack."

The university, if manned as it should

[1] Address before the Society of Sigma Xi at Stanford University, May 8, 1916.

be, is the ideal place for the development of fundamental research as contrasted with the more showy kind. If the tendency to forced stimulation of mediocre men, who have persistence and the leisure that may come from fellowships and scholarships, can be minimized, the universities can and eventually will become the seat of the greatest ferment, working out toward new discoveries.

Our whole concept of education has changed. It is now one of fact and not opinion. The "theological period" of assertion has largely gone by. There is no common source of information, no palladium such as the Bible is to religion, in modern science. What Agassiz says has no final value except to those who know his record, his trained mental processes, his method of arriving at pronouncements. We ask for foundations; we want to be able to see affirmation built up stone by stone; or we want to be able to work backwards and tear down the separate blocks, testing each and finding out thereby the real quality of the structure of assertions and theories formed by them. Allegiance to truth, as far as we can understand or discover the truth, is the main concern of the scientific worker of to-day. He knows that he must get into harmony with facts if his work is to be effective, to endure. Along with this appreciation of truth there has been a striking development of the conscience of the expert, who can only be partisan to the truth. The rescue of the so-called "expert" from his present unsavory position seems likly to follow the great advance in knowledge which has come from careful "fact study." We owe much of this very desirable change to the important body of information which has been brought together by those engaged in what we sometimes rather glibly call "research."

Research means a point of view, a type of mind, a healthy curiosity. It results in a welling up of inspiration. Our senses become blunt, our edges dulled to the usual, the old, the stereotyped. They keep acute to the new, the unexpected, the obscure, the intangible, the will-o'-the-wisp. For the interpretation of a subject to advanced students, only the mind alert in research, curious for the new, can be of the best service. Without that open point of view the solidification that usually begins in the early thirties of life soon becomes petrifaction. A noble mind has found its limits and will gradually wear off all its new contacts and beat its life out, leaving only the revolution of the treadmill to furnish evidence of activity. Freshened by contact with the new, the yet unexplained, the human intellect expands throughout life, becoming, through its constantly increasing store of fact and experience, more and more serviceable. Particularly is this true where the judgment has been developed through guiding others along the old paths and starting them off with compass and necessary equipment along the new paths which lead out to the maze and appealing mystery of the unknown.

The college or university teacher who fails to take a part in research in some form or another prunes himself of those branches that give promise of the best future fruit. There are many ways in which the research point of view may be maintained. It does not necessarily mean published work. It may be most serviceable to the teacher and yet show only in fresh thoughts, new stimulation to the student to think for himself, to investigate. It may be concerned largely with improvement in the presentation of subjects before classes. The man who devotes much of his time to research and experimental work and yet drags out the well-thumbed notes of bygone lectures to hammer at his classes is far from having the

research mind we need in the teacher. Such a man is of less value than the instructor who studies his subject but makes no pretense to so-called "productive work."

The research mind keeps up to date in its correlations and brings the inspiration of the best and newest into each teaching day. Sometimes one feels that the external drive towards research by university sentiment leads to many puny efforts and to abortive results. Perhaps, however, even though the result to science is small, the effect upon the individual is salutary. The greatest sport the world knows is the search for the absolutely new in any line. One need only sense the joy once to feel its lure.

I recall when working in Ehrlich's laboratory in Frankfurt his pleasure in each of the new chemical substances formed by him. He would make a new combination and show it to those working near him, even insist upon putting it into their hands to hold for a moment, saying: "Sehen Sie mal, jemand hat, es nie vorher gesehen; es ist ganz neu." Think of the satisfaction, the sport: "No one has ever seen it before; it is absolutely new." Who that could would not try a round in such a game? The successful players in it are those who have builded strong in mind and body—who have climbed to the upper heights, obscured by the mists, where the game is played. Each group of workers pushes the altitude upwards, broadens and solidifies the base, turns peaks into plateaus. The chosen few scale the lofty, unexplored spurs; the many join in filling in the gaps, opening up the intervening spaces, and making the secure level ground. We can not all be scouts; most of us must make up the rank and file of the army; some of us can only play the part of quartermasters.

The attitude of the university towards research should be a sane one. At times waves of research hysteria have swept over university circles and the sense of proportion has been lost. The number of published pages has seemed to be the standard of scholarship rather than the character of the work done. One has often seen research notes elaborated into articles; articles subsequently enlarged to monographs, and monographs padded out into books. The essential thing, however, is the discovered fact, the reasoning leading up to and away from the new fixed point. There is no common standard possible in this work nor in research in general; but the university can insist that the instruction offered by its research workers shall show that fresh and stimulating point of view, and that enthusiasm, that go with the growing mind that is abreast of the best thought in its subject. Under these conditions research will play that large part in the life of the university faculty which it should play, and students and teachers will make progress in their chosen fields.

Immortality is a theme upon which human thought has exhausted itself without absolute and universal conviction because it takes the human mind beyond its depth at the first long stride forward. But there is one phase of immortality about which we can all be assured. The mind of to-day can through the minds of to-morrow project itself into immortality. Ideas and ideals travel through generations of minds to eternity. It will ever be the inspiration of the teacher that to him in particular comes this great opportunity to be a part of the future, by moulding and guiding and training the minds of the present.

The man who discovers some new arrangement of forces, some new fact in regard to chromosomes, some fresh chemical combination, the cause of an obscure disease, has thereby become immortal, for his effort has added something which, if true, can not be lost to the human race. What

happier form of immortality than this—to have added something to the world's store of fact and of law!

Many then are the inspirations of research, and many the satisfactions of the teacher and the investigator. If we keep our view point clear, recognize the many ways in which new facts and new thoughts are garnered, avoid the spirit of pride and intolerance—we can be assured that from our university faculties there will come a spirit of research and of helpfulness that will act as a powerful factor in moving civilization onward and we hope upward.

RAY LYMAN WILBUR
STANFORD UNIVERSITY

CONTRIBUTIONS OF THE UNITED STATES COAST AND GEODETIC SURVEY TO GEODESY[1]

IN the earlier days of the Coast Survey, whose centennial is now being commemorated, the geodetic function, as such, was little in evidence. It was then simply an aid in carrying on the work outlined in the Act of 1807, which provided for a survey of the coasts of the United States, in order to provide accurate charts of every part of the coast and adjacent waters.

Upon the reorganization of the Survey in 1843, the cornerstone was laid for that fine system of geodetic works which the Survey has at present. In this reorganization two very prominent features, from a geodetic standpoint, are to be noted. The first is the man who was the dominant figure in the board of reorganization, and the second is the principles he advocated. Probably no other man has had the influence upon the geodetic operations of the Survey as had Superintendent F. R. Hassler, and probably no one thing has been of such importance to these operations as the scientific methods proposed by him. To him belongs the credit that to-day the operations of the Survey are bound together by a trigonometric survey with long lines, and executed by the most accurate instruments, and the most refined methods, rather than being correlated by purely astronomical observations. Due to his far-sightedness, the best of foundations was thus laid for geodetic operations, and from this time geodesy became an important part of the Survey's work.

A further impetus was given to the work when, shortly after the close of the Civil War, Congress authorized a geodetic connection between the Atlantic and Pacific coasts of the United States. The result of this was the great transcontinental arc of triangulation along the 39th parallel of latitude, one of the most famous arcs in the history of geodesy, and one which has helped to place the United States in the front rank of the nations carrying on geodetic operations. One of the immediate results was the recognition of the geodetic function as an important part of the Coast Survey's work, and in 1879 the Survey's title officially became "The Coast and Geodetic Survey."

THE TRANSCONTINENTAL ARC

The great triangulation system along the 39th parallel was probably the greatest single contribution to the world's geodesy that had been made by any one country. It marks an epoch in the scientific history of the United States and in that of the world. The results of the work are most important and far-reaching to geodesy, geography, geology, and the other earth sciences.

It is the longest arc of a parallel ever undertaken by a single nation, being more than 48° of longitude between its extremities, or about one-eighth of the earth's circuit, and is more than half the length of the combined arcs (measured by various

[1] Address given at the celebration of the centennial of the U. S. Coast and Geodetic Survey.

nations), used by Clarke in deriving the figure of the earth in 1880.

The nature of the country traversed by the arc developed new ideas in reconnoissance, signal building, triangulation and methods of computing, which have had an important bearing on all subsequent work. By means of it unity and consistency have been secured in the geodetic work of the Survey. It has proved a bond between the many separate parts of the Survey's work. These, at first, existed as a number of detached portions, in each of which the datum was necessarily dependent upon the astronomic observations. The transcontinental triangulations joined these detached portions and made them into one continuous system dependent upon the same geodetic and astronomic data.

From a higher scientific standpoint this arc is a great contribution to geodesy in giving data for the determination of the earth's shape and size, but like any other arc of a parallel, it must be combined with an arc in the north and south direction to obtain its full power in this respect.

THE EASTERN OBLIQUE ARC

In the Eastern Oblique arc the United States has another arc of note, which covers some 22°, and extends from the Bay of Fundy to the Gulf of Mexico at New Orleans. This was the direct result of Hassler's plans, was the scene of his last labors, and had for its main object the binding together of the detached surveys of the harbors of the Atlantic Coast.

Unlike the transcontinental arc, it has all the elements necessary for the determination of the figure of the earth. It is the first arc which made use, on a large scale, of measurements oblique to the meridian. One of its great effects on the geodesy of the United States was that, through it, came the rejection in 1880 of Bessel's spheroid of reference, and the adoption of the Clarke spheroid of 1866 as the reference spheroid to be used in this country.

ASSISTANT CHARLES A. SCHOTT

Many men took part in furnishing the data for these two arcs, and in the resulting computations, but no name stands forth so prominently as that of Assistant Charles A. Schott, the "Grand Old Man," who for more than fifty years was identified with the work of the Survey. His labors in the field and office did much to bring this work to a most successful finish, and it is fitting that credit be given him for the two monumental volumes of results which it was his privilege to see completed before death came. For this work, and for the work done in many other lines of the Survey's activities, I do not hesitate to mention the work of Mr. Schott as one of the great contributions made by the Coast and Geodetic Survey to the geodesy of the world.

The Survey was particularly fortunate in having such a man in charge of geodetic work; one who could see the full wisdom in the plans of Mr. Hassler, who consistently worked for their fulfilment, and who was able to have these plans transmitted to his successors, Assistant John F. Hayford and Assistant William Bowie. This furnished a continuity of plan which probably stands unrivaled in the scientific history of the world, and has been one of the big factors in the great success attendant upon the geodetic operations of the Survey.

RECENT TRIANGULATION

Since the completion of the arcs mentioned, the Coast and Geodetic Survey has added many more arcs to its system, until the total length of the combined arcs is more than 150° of a great circle of the earth, or about three sevenths of the circuit of the globe. Incorporated into the system

and placed on one datum are also the many miles of coast triangulation of the Survey and much of the triangulation executed by the Lake Survey and by the U. S. Engineers, until now the system stands without an equal in any nation.

In the closing years of the last century a new era in geodetic operations by the Coast and Geodetic Survey was begun. The work of the past was searched for the best in instruments and methods, field and office methods were standardized, limits of accuracy were set, and where it seemed advisable new methods and instruments were devised to meet the changing conditions of the work. This era may be characterized as a period of great speed and low costs.

Never before had triangulation been executed with such rapidity and with such economy in operations. It is significant that this was attained without a reduction in accuracy, and in fact had the effect of an ultimate increase in accuracy, for, owing to the speed, many more circuits could be added to the network, thus strengthening the whole system.

As an example of the speed and economy of operation in this last period the Texas-California arc of about 20° is cited. The reconnoissance on this arc was done by two men in 145 days and the primary observations in a total of 183 days at a cost of $400 per station and of $32 per mile of progress. Nearly 50 years were spent on the transcontinental arc of 48° with a cost of $2000 per station and $200 per mile of progress. This comparison is not intended to be derogatory to the latter arc, for the work on that arc was the best of any up to that date, and it was only through its work that the economy and speed of the later work was made possible. It is believed that no extensive arc in any other country equals the Texas-California arc or some of the other recent arcs of the United States, in these respects.

Since about 1900, practically all of the reconnoissance and signal building has been in the hands of one man, Signalman Jasper S. Bilby, who as an expert along these lines probably stands unrivaled in the world to-day.

THE UNITED STATES STANDARD DATUM

A direct and far-reaching geodetic movement of influence, not only to the United States, but also one of great importance to the North American continent, and also to the whole world, was initiated in the adoption by the Survey (in 1901) of the United States Standard Datum. It placed the geodetic work of the Survey on one datum for the correct coordination of the geographic latitudes, longitudes, distances and azimuths. From the scientist's standpoint it furnished accurate correlation of data for a study of the figure of the earth, of isostasy, and for other related sciences.

By its adoption, as the Standard Datum for geodetic operations in Canada and Mexico, it became a matter of international importance and consequently its designation was changed by the Survey in 1913 to that of the "North American Datum." Plans are now under way for carrying the primary triangulation of the United States and Canada to the Yukon, and the prediction is here made, that eventually the fifty miles which separate Alaska from Siberia will be spanned, and a junction be effected with the great systems of Asia, Europe and Africa. Then with the extension from Mexico through Central and South America, the data will be available for a "World Datum," and the final word will have been said in the geodetic work of the earth.

BASE LINE MEASUREMENTS

Closely related to, and forming an integral part of the triangulation executed by the Coast and Geodetic Survey, is the meas-

urement of the base lines for controlling the lengths in triangulation. In this work the Survey has furnished much of interest and of value to the geodesist. Ever has it kept keenly before it the necessity for refined measurements, and many valuable devices to accomplish this desired result have been added by members of the force.

BASE BARS

The Duplex bars, invented by Assistant William Eimbeck, are probably the best form of base bars ever devised and gave a very high degree of precision. But they were soon replaced by the tape as a form of base apparatus.

The only bar used in the United States, and probably in the world, which gives entire satisfaction, so far as accuracy is concerned, is the iced bar, designed by President R. S. Woodward of the Carnegie Institution when an assistant in the Survey. Owing to the great cost per kilometer of base of using this form of apparatus for field work, when compared with the cost of using tapes, the iced bar is now used only for standardizing other apparatus, and for this purpose it remains unexcelled.

STEEL TAPES

In the Coast and Geodetic Survey the tape has supplanted the other forms of base apparatus. Credit for the introduction of steel wires and tapes for this purpose must be given to Professor Jaderin of Sweden, but it was the accurate and extensive investigations made by Assistant Woodward in 1891 which caused the adoption of tapes by the Survey. He proved that steel tapes, when used at night, and standardized under the same conditions that prevail during the base measures, gave essentially the same high degree of accuracy as the Duplex bars, with about one third of the cost and with far greater rapidity. It is practically certain that no more base lines will be measured by base bars, at least in the United States, except when it is necessary to standardize the tapes.

The remarkable measurement of nine base lines in one season, in 1900, by a single party constitutes a noteworthy achievement. The nine bases had a total length of 43 miles and furnished a control of over 1,000 miles of triangulation. In order to eliminate constant errors five different sets of apparatus were used, and an average accuracy corresponding to a probable error of 1 part in 1,200,000 was secured. With this work a new epoch in base line measurement was introduced, for it proved, through the most rigid of tests, that the tape had no superior for speed, economy and ease of manipulation.

INVAR TAPES

In the use of invar tapes, base measuring took another long step forward. Many severe tests have fully proved their excellence. They are found to possess practically all of the good features of the steel tapes, but have the added advantage that they enable bases to be measured in the daytime and even in the sunny days, a fact due to the small coefficient of expansion of invar, which is only about one thirtieth that of the steel tapes.

Recently the plan has been adopted of having the bases measured by the triangulation party. By it base measurement has become simply an incident to the triangulation, and the cost has been reduced to about $60 per kilometer, a sum which is in great contrast to about $300 per kilometer with the Duplex bars.

PRECISE LEVELING

Practically all of the great nations of the earth have been actively engaged upon the difficult problem of determining the cor-

rect elevation of points far from their coast. It is a work which demands the highest degree of accurate observing and painstaking endeavor. It calls for especially designed instruments and methods of observation. These accurate elevations are needed for the reduction of base lines to mean sea-level, for engineering operations of wide extent, and for the solution of scientific problems concerning gravity, the tides and other work.

In this leveling of precision, the Coast and Geodetic Survey has added much to the world's work by attainments in field operations, methods of reduction and scientific study of errors involved. In its great precise level net (greater than that of any other nation) there are more than 15,000 bench marks, of which the elevations have all been accurately fixed through a single least square adjustment of more than 80 circuits with a total length of more than 25,000 miles.

THE COAST SURVEY LEVEL

Among the instruments of precision employed by the nations for precise level work, it may be truly said that none holds a higher rank than the type which has been in use in the Coast and Geodetic Survey since 1900. This level was designed and built within the Survey, and after more than fifteen years of constant service, in all parts of the United States, has shown itself to be indeed a superior instrument for accurate and rapid leveling.

Before the introduction of this level, the average rate of progress was less than 60 miles a month. Recent work, which is of much higher grade of accuracy, shows an average of nearly 80 miles; and one observer with a party of six men, last season completed 120 miles of progress, or more than 250 miles of single line in one month, which constitutes a world record.

Although precise leveling has been brought to the highest perfection in France, the Coast and Geodetic Survey, by the very magnitude of its operations, by the instruments employed, and by the economy in speed and cost, is certainly without an equal in the geodetic world.

ASTRONOMIC DETERMINATIONS

Considering astronomy as a definite part of its geodetic function, the Survey has added to the work done by the various nations many hundreds of astronomic latitude, longitude and azimuth determinations, mostly at stations connected directly with the great triangulation system. While no great changes have been introduced in latitude and azimuth work as far as instruments are concerned, there has been a decided change in speed and economy. Methods of observing and of computing have been standardized and this has greatly aided the work.

Since about 1904 all of the primary azimuths, in so far as was practicable, have been observed by the triangulation party during the progress of the work. It is believed that this plan gives the highest degree of accuracy, for the measurements are made under exactly the same conditions as the triangulation with which they are concerned, and the cost is very materially reduced.

TELEGRAPHIC LONGITUDES

The formation of the great telegraphic longitude net of the Coast and Geodetic Survey is a geodetic feat worthy of special note. No less than four transatlantic determinations have been made which serve to connect the longitudes of the United States with Greenwich and Paris, and more than 50 stations are included in the net which covers this country. Finally, through a transpacific determination made by the Survey, supplemented by a similar one

made by Canada, the last link in the telegraphic longitude circuit of the globe was completed, and thus nearly all of the longitude observations made in the world are united into one great single system, accurately correlated through this circuit.

THE TRANSIT MICROMETER

Among improvements made by the Survey to the instrumental equipment used in astronomic work only one will be mentioned. This is the transit micrometer used in the determination of time by stars at meridian passage. Although the transit micrometer had been in use at fixed observatories, it was not until the investigations made at the Coast and Geodetic Survey, in 1904, that its adaptability to portable transits was thoroughly proved. The many tests it has had in actual field work have shown for it many features of excellence. With its use, the relative personal equation between two observers is so small as to be masked by the accidental errors of observation and is certainly not more than one tenth as large as the average using the key. No interchange of observers is necessary, and the time of the determination of a difference of longitude is about one half the time taken by the older method.

THE FIGURE OF THE EARTH

The very important problem of determining the shape and size of the earth is probably the climax, from the scientific point of view, in the geodetic work of the Survey.

Reference has already been made to the use of the arcs of triangulation in determining the figure of the earth. When many arcs, both meridional and latitudinal, are all joined together on the same trigonometric and astronomic basis, the area method, developed in the Coast and Geodetic Survey since about 1901, is, without doubt, far superior to the arc method. In it are all of the features of the arc method, to which many important new features are added. Using the great system of triangulation in the United States to furnish the area factor and the many astronomical measures connected with the system to furnish the curvature factors, a value for the figure of the earth was derived which is of a very high degree of accuracy. The investigations and results obtained in this work are noteworthy contributions to geodesy. Some of the prominent features of this investigation are shown in the wide area treated, the large number of astronomic observations involved, and the unusual methods of computation used. Topographic irregularities within 4,000 kilometers of each astronomic station were considered, and account was taken of possible distribution of density beneath the surface of the earth. These features, together with the actual results obtained, make this a monumental work.

By a study of the station errors, or deflections in the verticals, which were developed when the astronomical and geodetic measures were compared, evidence was brought forth which established the fact that the condition of isostasy exists in the earth—a fact which is of interest and value to geodesy and geology.

These studies of the figure of the earth and isostasy have attracted the attention of the scientific world. Dr. Woodward, the distinguished geodesist, is authority for the statement that the work done by the Coast and Geodetic Survey on isostasy is the greatest contribution to geodesy since the time of Bessel and Gauss.

GRAVITY MEASURES

Another method of attacking this important problem of the earth's shape and size is by the use of the pendulum in the determination of gravity. The contribution of

the Coast and Geodetic Survey to this field of geodesy are given in the results of more than 30 foreign stations and of nearly 200 stations in the United States.

Happily the gravity conference held in 1882 endorsed the plan of using the invariable pendulum, and of employing the differential method of carrying on gravity work, and the Survey's present excellent equipment and methods are the direct results. In its present type of apparatus, known as the Mendenhall pendulums, the Survey has a form which for compactness, portability, precision and ease of operation ranks well among the highest in this field of endeavor.

Two features in recent gravity work are worthy of note. One is the application of the interferometer to the measurement of the flexure of the pendulum support, thus giving a direct measurement of this small quantity in terms of a wave-length of light. It is believed that the resulting corrections to the period of the pendulum are more accurate than those by the older static method where the corrections were derived under exaggerated conditions. The interferometer has been in use for about 8 years as a field instrument, and determinations of the flexure have been made at about 140 gravity stations, through a very wide range of conditions in piers and external vibrations.

The second feature worthy of note in recent gravity work is the deriving of the rate of the chronometers by Western Union time signals at noon—a distinct advantage over the older method. By it the local time observations are dispensed with, the time of occupation of a station is decreased and the labor of preparing the station greatly lessened, all of which contribute to a lowering of the cost per station occupied. In connection with this it is interesting to note that Assistant Schott in 1882 made the statement that

> Time furnished telegraphically by an observatory whose clock is protected from changes of temperature and pressure will be preferable to any local determination at a field station.

FIELD AND OFFICE FORCE

Little has been said of the men who have composed and do now compose the field and office force of the Coast and Geodetic Survey. What the Survey is and accomplishes is due to these men, and to the spirit which influences them. To them must be given the credit for much that the Survey has contributed to geodesy. It would be difficult to find a body of men of greater enthusiasm for, or a higher scientific attitude toward their work. They have a careful devotion, to duty and an interest in the success of the Survey and its work, a fact which has developed a corps of workers of unrivalled excellence.

They have ever been most alert to adapt new discoveries, made in the various fields of science, to the needs of the Survey, and to plan new and improved instruments; while to the theoretical work of geodesy they have added much by critical discussion and extensive study of results.

Workers must have tools, and this fine body of skilled observers would be seriously handicapped in their work if suitable equipment were not furnished them. The Survey is particularly fortunate in having a body of skilled artisans in the Instrument Division, under the supervision of a most highly efficient officer. In this division there have been designed or built nearly all of the instruments of precision which have helped so materially to place the Coast and Geodetic Survey in its present high position.

Of the relation of the geodetic work of the Survey to that of the world, as shown by its share in the operations of the International Geodetic Conference, only slight reference is here made, for this subject is dealt with in another address by the former

Superintendent Tittman who is much more capable of addressing you on this subject.

In the foregoing, the endeavor has been made to give some idea of the contributions which the Coast and Geodetic Survey has made to geodesy. Of necessity much has been omitted, but what has been given will bear witness that the world's geodesy has been greatly enriched by the work of the Survey.

A test of the greatness of the geodetic work of the Survey may be had in a review of the comments made by prominent men in other organizations and countries, by men who are well qualified to judge. They all accord to the geodetic work of the Survey a very high place in the geodesy of the world. One comment only will be here given as a fitting close to this brief review of the contributions made by the Coast and Geodetic Survey to geodesy.

Commandant Perrier, the French geodesist, in speaking of the work of the Survey, says:

> There is no example in the history of geodesy of a comparable collection of measurements, made with so much decision, such rapidity and such powerful means of action, and guided by such an exact comprehension of the end to be attained.

WILLIAM H. BURGER

COLLEGE OF ENGINEERING,
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PITTSBURGH'S FIRST CHEMICAL SOCIETY[1]

IN *The Commonwealth,* a Pittsburgh weekly newspaper, of November 4, 1811, there was an advertisement to the effect that Dr. Aigster would deliver an introductory lecture on chemistry, Wednesday, November 6, at 3 P.M. in the grand jury room at the Court House. The advertisement concluded with this striking sentence:

[1] This paper was read before the Historical Society of Western Pennsylvania on January 25, 1916.

> All friends of science will be gratuitously admitted.

The Pittsburgh Gazette, of December 20, 1811, carried the following advertisement:

> The subscribers to Dr. Aigster's Chemical Lectures are informed that the regular lectures will begin on Monday, the 16th of December, at the Laboratory, corner of Smithfield and Second Streets, at 3 o'clock P.M., to be continued from that time every Monday, Friday and Saturday at the same hour and at the same place. Further subscription will be received at the Laboratory.

That Dr. Aigster was not unlike many modern lecturers on scientific subjects is seen from an announcement in the *Gazette* of December 27, 1811, that Cramer, Spear and Eichbaum had just published a discourse, introductory to a course of lectures on chemistry, which included "a view of the subject and the utility of that science, delivered at Pittsburgh on the 6th of November by F. Aigster, M.D."

There is a copy of this discourse bound with Cramer's Pittsburgh Magazine Almanacks for 1816 and 1817 in the Carnegie Library of Pittsburgh. The lecture discusses in the words of Dr. Aigster, "the application of chemical knowledge in private and social life." It describes the applications of chemistry to agriculture, mining, cloth making, glass making, brewing, tanning, paper making and, last but not least, to cookery.

Some of Dr. Aigster's statements sound as if his lecture were delivered yesterday. Witness this:

> The time is come when America can shake off the yoke of foreign dependency for a number of the most necessary wants, whose first material, bountiful nature has scattered with lavish hands over this country.

And this:

> A laudable beginning has been made in the wool, flax and cotton manufactures. But it can never be expected that they will attain any high degree of improvement as long as the art of dyeing, which is altogether chemical, is not attended to.

In a latter part of a lecture Dr. Aigster says that while the history of chemistry in America is short, it contains a few names which would do honor to the proudest nations of the ancient world. He mentions the names of Dr. Benjamin Rush, of Philadelphia, Dr. Samuel L. Mitchill, of New York, Dr. Woodhouse, of Philadelphia, Dr. M'Clean, of Princeton, Professor Silliman, of New Haven, Dr. I. Redman Coxe, of Philadelphia, Joseph Priestley, and Mr. Thomas Cooper, who he states was his successor as professor of chemistry at Dickinson College.

Following the discourse is a syllabus on chemistry which is divided into three sections:

1. General forces productive of chemical phenomena.
2. Of the general properties and relations of individual substances.
3. Chemical examinations of organized nature.

That Dr. Aigster was interested in the practicable application of some of his theories will be seen from the following note in the Pittsburgh Magazine Almanack for 1812:

> Proposals for the formation of a company for the purpose of establishing a combined manufactury of sulphurick acid (oil of vitriol), of nitrick acid (aqua fortis) and of allum have been lately issued by Dr. Aigster, formerly professor of chemistry in Dickinson College, Carlisle, now resident in Pittsburgh.

The note then goes on to outline the process and the prospects for success.

In the Directory of Pittsburgh for 1815, which was the first directory, Dr. Aigster's Christian name is given as Frederick, his residence "in the Diamond" and his profession as "physician and chymist."

Sarah Killikelly, in her history of Pittsburgh, says that perhaps out of the series of lectures by Dr. Aigster grew the Pittsburgh Chemical and Physiological Society.[1] This is no doubt true, as Dr. Aigster's name appears in the list of honorary members of the Columbian Chemical Society of Philadelphia, which was founded in 1811, and the Pittsburgh Society appears to have been modeled very closely after the Philadelphia Society.

At all events, a notice appeared in one of the weeklies requesting persons interested to "meet at A. M. Bolton's Academy Hall, Market Street, on Friday evening October twenty-ninth, 1813, at 6 o'clock, for the purpose of organizing the Institution and electing officers."

At the next meeting, on November 12, the following officers were elected:

President, Dr. B. Troost.
Secretary, J. B. Trevor.
Treasurer, S. Pettigrew.
Lecturer, Dr. E. Ramsey.
Librarian, A. M. Bolton.
Annual Orator, Rev. D. Graham.

At the time of the organization of this Chemical Society, the population of these United States was about 7,000,000 and of the borough of Pittsburgh about 7,000. Some of the advertisements which appeared in the papers at that time will give an idea as to why, with so small a population, there was a live interest in chemistry.

> PAPER MAKERS WANTED
>
> Two paper makers, one who is competent to superintend a paper mill and is well acquainted with the whole art and mystery of paper making, the other to work as a journeyman.
>
> ---
>
> The highest price in cash will be given for a quantity of merchantable potash. Apply to Anthony Beelen.
>
> GLASS BLOWING
>
> Wanted, two or three sober lads, fourteen to sixteen years of age, as apprentices to above business.

[1] Killikelly, Sarah H., "History of Pittsburgh." B. C. and Gordon Montgomery Company, Pittsburgh, 1906.

Cash given for pot and pearl ash.

TREVOR AND ENCELL

DR. G. DAWSON

Family, patent and horse medicine, surgeon's instruments, paints of all kinds, spirits of turpentine, spices, perfumery, oils, varnish, etc.

ASHES

The subscriber will give 25 cents per bushel for any quantity of good oak and hickory ashes, delivered at his soap and candle manufactory, corner of Ferry and Third Streets.

NICHOLAS O'CALLAGHAN

NITRE

Warranted in its pure stage, refined by the subscriber and for sale at John McClean's commission warehouse. It may also be had particularly prepared for manufacturing gun powder, by CHARLES MUNNS, Gun Powder maker and Salt Petre refiner.

Well, to come back to the Chemical and Physiological Society. The advertisements in the papers after the initial meeting were very few. Newspapers were not so liberal with their space as now. A notice appeared in February, 1814, to the effect that there would be a lecture on "the singular properties and effects of nitrous oxide or, as it is sometimes called, the exhilarating gas, Friday evening, February 25, 1814."

On November 2, 1814, the *Mercury* carried the following advertisement:

A stated meeting of the Chemical and Physiological Society will be held at the usual place, on Thursday evening next, at 7 o'clock.

The punctual attendance of the members is particularly requested, in order to make the necessary arrangements for the delivery of the annual oration at the succeeding meeting.

The election of officers will be held on the 10th instant, agreeable to the constitution.

J. B. TREVOR, *Secretary*

There is no record as to what was the subject of the annual oration, but there is a record that at the meeting following the election Dr. Troost talked "on oxygen gas accompanied with several interesting experiments."

The Directory for 1815 tells something of the Society and gives a list of officers who were elected at the meeting on Thursday, November 10, 1814, in the following notice:

THE PITTSBURGH CHEMICAL AND PHYSIOLOGICAL SOCIETY

This society was formed in 1813, by a number of scientific gentlemen resident in Pittsburgh, and has since rapidly increased.

There are at present belonging to the society, a Library, Chemical and Philosophical apparatus, and a valuable cabinet of mineralogy.

Their meetings are held every two weeks, in a room appropriated for that purpose in the Court House.

President, Walter Forward.
Secretary, Harmar Denny.
Treasurer, Samuel Pettigrew.
Librarian, Lewis Peterson.
Lecturer on Chemistry, Dr. B. Troost.
Botany, M. M. Murray.
Anatomy, Dr. Joel Lewis.
Mineralogy, Dr. F. Aigster.
Astronomy and Natural Philosophy, Joseph Patterson.
Annalist, Aquila M. Bolton.
Annual Orator, J. B. Trevor.

Walter Forward, who is given as the President, was an attorney-at-law, who in 1819 became one of the twenty-six incorporators of the Western University of Pennsylvania, now the University of Pittsburgh. In 1841 he was appointed by President Harrison to be the controller of the United States and in that same year he was made Secretary of the Treasury of the United States by President Tyler.

Harmar Denny, who is given as the Secretary, was the son of Ebenezer Denny, who, in 1816, became the first Mayor of Pittsburgh. Harmar Denny, when he was elected Secretary, had just been graduated from Dickinson College where he had undoubtedly studied chemistry under Thomas Cooper who was professor of chemistry at Dickinson College from 1811 to 1814.

The election notice, signed by Harmar

Denny, appeared on November 15, 1814, and on December 14, 1814, the following notice appeared:

A special meeting will be held at the Society Hall next Thursday at half past six.

HARMAR DENNY, *Secretary*

Why a special meeting so soon after the election? Did Messrs. Troost and Trevor resent the fact that they were not reelected to their former positions, or had interest in things scientific declined in the borough? Perhaps it was the pressure of business, for less than a month after this notice the newly organized firm of Trevor, Pettigrew and Troost announced that the Western Eagle Lead Factory was in complete operation. The members of this firm later advertised that "they also manufacture, at their chemical laboratory, alcohol, ether, sweet spirits of nitre, aqua fortis, muriatic acid, red precipitate, calomel and chemical preparations generally."

At least one member of this firm, Dr. Troost, did not lose his interest in pure chemistry, for in 1827 he was elected lecturer in chemistry for the Pittsburgh Philosophical and Philological Society, of which Rev. Robert Bruce, the first chancellor of the University of Pittsburgh, was president.

But, to come back to the Chemical Society, it is almost certain that the Society was disbanded at the special meeting of December 14, 1814, for no other notices of meetings appeared in the newspapers.

It is interesting to know that the Pittsburgh Chemical Society was undoubtedly the third in the United States. It was preceded by two Philadelphia societies, the Chemical Society of Philadelphia, founded by James Woodhouse in 1792, and the Columbian Society of Philadelphia, founded in 1811.[3]

Pittsburghers have every reason to be proud of the fact that so early in the history of the city, which was then a frontier town, away on the other side of the mountains, there was a live interest in science, and, especially, in that branch of science which has contributed so much to the industrial progress of the city.

JOHN O'CONNOR, JR.

MELLON INSTITUTE,
UNIVERSITY OF PITTSBURGH

[3] Smith, Edgar Fahs, "Chemistry in America," D. Appleton and Company, 1914.

THE SAN DIEGO MEETING OF THE PACIFIC DIVISION OF THE AMERICAN ASSOCIATION

ASTRONOMICAL SOCIETY OF THE PACIFIC

THE Astronomical Society of the Pacific will hold sessions in San Diego on Thursday and Friday, August 10 and 11, at the time of the meeting of the Pacific Division of the American Association for the Advancement of Science. In these sessions the Astronomical Society of Pomona College will participate.

The opening paper of the program will be presented by Professor S. D. Townley, of Stanford University, president of the society. A number of other papers have been promised by astronomers of the Pacific Coast, and an interesting program is assured. A special feature of the program will be discussion of problems presented by the nebulæ. Attention is also called to the fact that the address on August 9 by the president of the Pacific Division A. A. A. S., Dr. W. W. Campbell, will be on the subject "What we know about Comets."

The titles of papers offered by members of the Society or of the Pacific Division for this meeting should be in the hands of the chairman of the program committee, R. G. Aitken, Mount Hamilton, California, before July 10, and abstracts should be submitted before July 29. It is especially requested that these abstracts be worded in popular language, as it is planned to print them in the daily press.

CORDILLERAN SECTION OF THE GEOLOGICAL SOCIETY OF AMERICA

A MEETING of the Cordilleran Section of the Geological Society of America has been ap-

pointed in conjunction with the meeting of the Pacific Division of the American Association for the Advancement of Science, in San Diego, on the dates August 9, 10 and 11, 1916. Titles of papers from members of this society to be presented at this meeting should be sent to the secretary, J. A. Taff, 781 Flood Building, San Francisco, before July 20. An abstract of about 250 words should be submitted with each title. Papers will also be welcomed from members of the Pacific Coast Section of the Paleontological Society and from the Seismological Society of America who may attend this meeting, in case these societies do not also hold meetings.

Excursions in the vicinity of San Diego will be arranged for members of the Section who desire to see geologic features of this region which are of peculiar interest. Among these features may be mentioned the cliff section of Point Loma, the great Coronado sand-spit which has formed San Diego Bay, the marine terraces on San Clemente Island, and the pegmatite dikes near Pala and Mesa Grande in which valuable deposits of gem tourmaline, garnet and kunzite have been found. The high granite peneplain of the Perris Valley and the Salton Sink and irrigation projects of the Imperial Valley may also be reached by automobile from San Diego.

J. A. TAFF,
Secretary

PACIFIC SLOPE BRANCH, AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

THE first meeting of the Pacific Slope Branch of the American Association of Economic Entomologists will be held in conjunction with the meeting of the Pacific Division of the American Association for the Advancement of Science in San Diego, California, between the dates August 9 and 12, 1916. An important feature of this meeting will be the completion of the organization of the branch and the formulation of plans for future work.

Among the papers which have already been offered for the San Diego meeting are:

"Host Relations of Ecto-parasites," by Vernon L. Kellogg, Stanford University, California.

"Economic Syrphidæ in California," by W. M. Davidson, United States Bureau of Entomology, Walnut Creek, California.

"The Chrysanthemum Gall-fly," by E. O. Essig, University of California, Berkeley.

"Some Scale Insects of Oregon," by LeRoy Childs, Oregon Agricultural College, Hood River.

"The Fruit-tree Leaf Syneta, Spraying Data and Biological Notes," by George F. Mozenette, Oregon Agricultural College, Corvallis, Oregon.

Titles of other papers to be presented at this meeting, together with abstracts, should be submitted to the secretary before July 20.

E. O. ESSIG,
Secretary

UNIVERSITY OF CALIFORNIA

WESTERN SOCIETY OF NATURALISTS

THE first meeting of the Western Society of Naturalists will be held in San Diego on August 10 and 11, in conjunction with the meeting of the Pacific Division of the American Association for the Advancement of Science. The San Diego Natural History Society and the Pacific Coast Branch of the American Phytopathological Society will also participate in the meeting of the Western Society of Naturalists.

At these sessions a number of papers will be presented upon a wide range of topics of general biology which will be of interest to botanists and zoologists and also to the general public. Worthy papers upon more limited fields of zoology or botany will also be welcome. Titles of papers, together with brief abstracts, should be submitted to the secretary of the society, E. L. Michael, La Jolla, California, before July 20.

Among the papers already offered for this meeting are the following:

"Composition of the Rancho La Brea Fauna," by John C. Merriam, professor of paleontology and historical geology, University of California.

"Eugenics and War; and Isolation and Production of Germinate Species," by David Starr Jordan, chancellor, Stanford University.

"An Amateur Naturalist in Formosa," by Dr. Fred Baker, Point Loma.

"Biology's Contribution to a System of Morals Adequate for Modern Civilization," by W. E.

Ritter, scientific director, Scripps Institution for Biological Research, La Jolla.

"The Mutation Theory and the Species-concept," by R. R. Gates, acting associate professor of zoology, University of California.

Papers will also be presented by Professor H. M. Hall, Dr. Joseph Grinnell and Mr. Tracy I. Storer, of the University of California; by Dr. D. T. MacDougal, Desert Botanical Laboratory, Tucson; Professor Harry Beal Torrey, Reed College, Portland, and others.

On Thursday afternoon, August 10, the session will take the form of a conference upon the tuna fisheries of southern California. A consideration of the tuna fisheries is especially appropriate at this time in view of the recent development of this industry, the establishment of tuna canneries at San Diego and other ports of southern California, and the work of the *Albatross* of the United States Bureau of Fisheries in tuna investigations in southern California waters this summer.

Barton W. Evermann,
President

SCIENTIFIC NOTES AND NEWS

Dr. Henry M. Howe, emeritus professor of metallurgy in Columbia University, has been appointed honorary vice-president of the Iron and Steel Institute of Great Britain.

The Paris Academy of Sciences has elected as correspondent in the section of medicine and surgery in succession to the late Professor Mosso, of Turin, Dr. Bergonié, professor of biological physics and medical electricity at Bordeaux.

An honorary degree was conferred by the University of California at its fifty-third commencement exercises on John Stillman, professor of chemistry in and vice-president of Stanford University.

Samuel Gibson Dixon, Pennsylvania state health commissioner and president of the Philadelphia Academy of Natural Sciences, received the degree of Sc.D. from Lafayette College at the annual commencement on June 14.

At the annual commencement of the University of Cincinnati, on June 10, the honorary degree of doctor of science was conferred on Professor John Uri Lloyd, Cincinnati, known for his contributions to chemistry and pharmacy.

George Freeman Parmenter, Merrill professor of chemistry in Colby College, has been given the degree of doctor of science by the college.

At its recent commencement the University of Pennsylvania conferred on Daniel Lincoln Wallace, the degree of doctor in chemistry.

Dr. Charles Willems, surgeon of Ghent, has been elected a foreign correspondent of the Paris Academy of Medicine.

At the annual meeting of the American Academy of Medicine, held in Detroit, on June 12, the following officers were elected: president, Dr. Jacob E. Tuckerman, Cleveland; vice-presidents, Dr. Frederick L. Van Sickle, Olyphant, Pa., and Dr. Ray Connor, Detroit, and secretary, Dr. Thomas W. Grayson, Pittsburgh.

Dr. Allen K. Krause, of the Saranac Lake (N. Y.) laboratories, will take charge of the work on tuberculosis in the Phipps laboratories of the Johns Hopkins University, made possible by the recent gift of Mr. Kenneth Dows.

Dr. H. R. Wahl, associate in pathology, Western Reserve Medical School, has been elected director of laboratories in the new Mount Sinai Hospital.

Professor Selskar M. Gunn, director of the division of hygiene of the Massachusetts State Department of Health, has resigned.

Willard J. Fisher, head of the department of physics at the New Hampshire College, has retired to devote himself to research work.

Frederic A. Harvey, Ph.D., has resigned from the faculty of Syracuse University to accept a position as technical physicist with the Solvay Process Co., at Syracuse, N. Y.

Professors W. B. Cannon, of Harvard University, Frederic S. Lee, of Columbia University, and William H. Park, of New York University, and Drs. McCoy and Eichorn, of

Washington, on June 19, spoke in Washington before the senate committee on agriculture and forestry in opposition to the bill now before congress, which provides for an investigation of animal experimentation throughout the country. A considerable delegation of antivivisectionists urged the passage of the bill.

A COMMISSION constituted by the International Health Board of the Rockefeller Foundation sailed on the *Almirante* on June 14, on a trip to various points of South America where yellow fever is still reported to exist. The commission is headed by Major General William C. Gorgas, U. S. Army, who has obtained four months' leave of absence for this purpose. The other members are Assistant Surgeon General Henry R. Carter, U. S. P. H. S., clinician; Dr. Juan Guiteras, head of the Public Health Service of Cuba, clinician and general adviser; Major Theodore C. Lyster, M. C., U. S. Army, clinician; Major Eugene R. Whitmore, M. C., U. S. Army, pathologist; Sanitary Engineer William D. Wrightson, U. S. P. H. S., sanitary engineer, and Harry H. Wakefield, secretary.

DR. ALLERTON S. CUSHMAN, of the Institute of Industrial Research, Washington, D. C., gave an address before Sigma Xi at the Worcester Polytechnic Institute on June 5, 1916, on "Science and Civilization."

WE learn from the *Journal* of the American Medical Association that a memorial service to the late Dr. Frank W. Reilly, for many years assistant commissioner of health of Chicago, and at one time secretary of the Illinois State Board of Health, was held on June 21, when the Frank W. Reilly Public School at School Street and Lawndale Avenue was dedicated. The principal addresses were delivered by Superintendent of Schools John D. Shoop; President Jacob M. Loeb, of the Board of Education; Dr. Arthur R. Reynolds, former health commissioner, and Dr. Alfred C. Cotton.

ON the occasion of the meeting of the Western Reserve University Medical Alumni Association, June 8, 9 and 10, President Charles F. Thwing formally accepted on behalf of the university, its trustees, etc., portraits of two former professors in the medical school, namely, Dr. Gustav C. E. Weber, formerly professor of surgery, and Dr. Hunter H. Powell, formerly professor of obstetrics and diseases of children. Presentations on behalf of the Alumni Association were made by Drs. W. T. Corlett and A. H. Bill, respectively.

DR. SAMUEL G. DIXON, president of the Academy of Natural Sciences, has proposed to the mayor of Philadelphia that the statue of Joseph Leidy, now badly placed on City Hall Square, should be erected, at least temporarily, near the academy in the greenery of Logan Square.

AMONG those killed in the naval action in the North Sea on May 31 was Commander H. L. L. Pennell, one of officers of the *Terra Nova* in the British Antarctic Expedition of 1910.

THE meeting of Scandinavian naturalists will be held in Christiania on July 10 to 14.

THE Yorkshire Agricultural Union has decided to open a national fund for the representation of agriculture in the British parliament by practical agriculturists.

THE Graduate School of the University of Illinois has recently made an appropriation for a geological expedition to Hudson Bay during the summer of 1916. The work will be in charge of Professor T. E. Savage and Dr. F. M. Van Tuyl, of the department of geology, who will be in that region from the latter part of June to the middle of September. It is planned to examine the outcrops and make detailed collections of fossils along most of the larger rivers south of the Churchill on the west side of the bay, in an effort to obtain more definite information concerning the Paleozoic succession and the ancient sea connections in that part of the continent. Evidences of recent elevation of the shore line, and other features will also be studied.

THE publication of agricultural bulletins for the benefit of the farmers of New York state will be discontinued for some time because the governor vetoed the legislative printing appropriation. He vetoed it because, despite

his warning to the legislature, the bill proposed to appropriate the money, about $200,000, in a lump sum instead of by items. His veto cuts off all provision for the expense of legislative printing this year. The Geneva and Cornell experiment stations have had about $60,000 apiece yearly for the printing of reports and bulletins, and this money has been appropriated under the head of legislative printing. Reports of all state institutions have been covered under that head. Bulletins such as the agricultural experiment stations have issued throughout the year for the information of farmers have been officially regarded as anticipating parts of the annual reports of the stations. Part I. of the annual report of the college has comprised the report itself and technical bulletins; Part II. has been made up of the matter intended for popular use, such as bulletins of general value and the reading course lessons of the year.

UNIVERSITY AND EDUCATIONAL NEWS

Mrs. Russell Sage has given $75,000 to Knox College of Galesburg, Ill., to make possible the securing of the amount to complete its half-million-dollar endowment fund.

The alumni of the University of California Medical School have offered to give $400 a year for five years to maintain the William Watt Kerr scholarship in medicine in honor of Dr. Kerr, clinical professor of medicine in the University of California.

Miss Charlotte Emily Beckwith has bequeathed one half of the residue of her estate, which amounts to about £8,000, to the Victoria University of Manchester in aid of the "John Henry Beckwith Scholarship" founded by her mother.

A large company of representatives of the scientific and technical press were received at the Imperial College of Science, South Kensington, on May 31 by the Right Hon. Arthur Dyke Acland, chairman of the executive committee of the governing body, and, with the professors and other members of the staff, took them round the institution. Mr. Acland referred to the memorial which has just been presented to Lord Crewe by the professors of the college, urging the importance of securing that a larger proportion of young men in this country should be trained in scientific methods with a view to industrial research. The suggestion is that a grant of a quarter or half a million pounds, in addition to the quarter of a million (as against Germany's million and a half) which the state annually grants to the universities might profitably be used to provide an adequate number of bursaries for secondary-school boys of 16 to 18 years of age, to be followed by the offer of government scholarships tenable at a university.

Professor Mary Whiton Calkins, of Wellesley College, has been appointed lecturer on the Mills Foundation in the department of philosophy of the University of California for the half year ending December 31, 1916—the lectureship held for the past year by Professor George H. Palmer, of Harvard University.

The vacancy in geology in the University of Kansas, caused by the resignation of Professor W. H. Twenhofel, has been filled by the election of Dr. Raymond C. Moore, of the University of Chicago.

At the June meeting of the board of regents of the University of Nebraska Dr. Raymond J. Pool was elected permanent head of the department of botany. Professor Pool had been acting head of the department since the death of Professor Bessey in February, 1915.

Dr. Charles C. Adams has been promoted to the professorship of forest zoology in the newly formed department of forest zoology in the New York State College of Forestry at Syracuse University.

As assistant professor of industrial hygiene of the medical college of the Ohio State University, Dr. Emery R. Hayhurst, an authority on the subject of occupational diseases and the relation of industrial problems to the preventable diseases caused by workshop conditions, has resigned as chief of the division of occupational diseases of the state department of health and will devote his entire time to the Ohio State Medical College.

AT the last meeting of the corporation of the Massachusetttts Institute of Technology promotions and appointments were made to the instructing staff as follows: From assistant to associate professor Daniel F. Comstock (theoretical physics), George L. Homer (topographical surveying), C. L. E. Moore (mathematics), Ellwood B. Spear (inorganic chemistry), William E. Wickenden (electrical engineering). Instructors were promoted to assistant professorships as follows: James M. Barker (structural engineering), Ralph G. Hudson and Waldo V. Lyon (electrical engineering), Earl B. Millard (theoretical chemistry). Dr. Frederick G. Keyes was appointed associate professor of physico-chemical research.

DISCUSSION AND CORRESPONDENCE

SOME FUNDAMENTAL DIFFICULTIES OF MECHANICS

A LONG and interesting exchange of views on the fundamental equation of mechanics, which has taken place in the columns of SCIENCE, has led me to review some old notes in that connection. It has seemed to me that the question may be viewed from two different points, that of the systematizer and that of the teacher. The former desires an equation, fundamental in that from it he can develop the science most easily. The latter must consider as the fundamental principles those which appeal most directly and forcibly to the student, which enable the student to progress most easily, with rapidity and security. By *the student* I mean the average student, who has much experience of a mechanical nature, but is unaccustomed to logic and cares little about unity.

To the teacher of mechanics students in masses, that is, to nearly every mechanics or physics teacher, even in college and technical school, the first-named viewpoint is unimportant as compared with the second. His business is to diagnose the student's difficulties, and then to obviate or remove them. Some of these difficulties are inherent in the laws of mind and matter.

Any teacher will admit that to the average student the descriptive, phenomenological, attitude toward mechanics is quite too rarefied, too impersonal. Professor C. R. Mann has well said:

> To a beginner pushes and pulls are the real forces.

The beginner can imagine himself pushing or pulling, exerting an effort and taking an interest. Descriptively, it has been questioned whether the concept of force is of much value in mechanics; but the sense and memory of effort give the student his starting point, and the teacher must begin kinetics with force as well as with acceleration and mass.

When we exert effort we observe we either change the motion of bodies, or change the relative positions of bodies or of their parts, hence the forms of bodies. During such changes of position or form, more or less temporary changes of motion occur.

Hence we all quite unnecessarily infer that when the motions of bodies are changed, or their relative positions, or their forms, there must be something going on analogous to an effort; this we call force, and we say that the above effects of effort are the effects of force.

Moreover, we observe that while the changes of relative position or form of bodies due to our effort may persist after we have ceased to exert effort, on the contrary the motion which has been produced by an effort does not continue, it always diminishes and finally ceases. We note that the effort needed for the production or increase of motion depends on the contact of the body acted on with other things, as soil, pavement, ice; water, if floating; oil, if lubricated; air, if swinging suspended; and also on the form of the body, flat or jagged or round. In some cases the production of motion is harder, in others easier, the duration of the motions is shorter or longer, but sooner or later the motions end in rest. If we want a thing to keep going we have to keep pushing or pulling; and this without exception in all our bodily experience.

Hence we hastily but naturally conclude that rest is the natural state of all bodies, and that for the maintenance of even constant motion continuous effort, or force, is necessary.

It has been pointed out that the scholastic

dictum about the necessity of force for the maintenance of motion is thus a consequence of common experience, a deduction of "common sense," which is the result of common experience. And while the common experience of boys and young men is changeable from age to age and different from one culture level to another, while men in the age of stone clubs or in the days of the stage coach had a range of common experience vastly different from what they have in an era of electricity and gasolene, nevertheless this element of terrestrial experience persists in them all—to maintain motion force must be continuously exerted; force lacking, rest supervenes.

Galileo's principle of inertia, then, Newton's first law of motion, is not a deduction of common sense, because it contradicts common experience. Only uncommon experience, interpreted by an uncommon mind, could arrive at it; and it is a fact that the world waited many ages for a genius to arise, fly in the face of common terrestrial experience, announce that the immediate consequence of force is acceleration, and interpret the inevitable extinction of unsupported terrestrial motions by the hypothesis of a force of friction, always opposing the existing motion and producing a negative acceleration. And the clear grasp of the inertia principle could only follow the study of a frictionless system.

Here we have the first difficulty of kinetics; its first law contradicts the student's common sense and all his ingrained mechanical experience. I doubt that many students, seeing the experiment for coefficient of friction, with horizontal slab, pulley and cord, actually interpret the slow uniform motion of the block in terms of two equal and opposed horizontal forces, producing each its own acceleration. It seems too far fetched; rather say, if you stop pulling the slab stops—and have done with it. And so with all the movements of wind and water; they go on because somehow they are driven. And so also Kepler interpreted the motion of the planet Mars in its orbit as due to a forward tangential force arising no doubt in the sun; and the schoolmen said that bodies fall with speeds proportional to their weights—which is roughly true for snowflakes and raindrops.

Change of motion, quantitatively called acceleration, is an idea rather remote from common experience. Every player of games is familiar with it in a crude way, but that it is a measurable quantity, or worth measuring, never entered any head before Galileo's. This is not at all remarkable, when we consider that speed is not given us by direct measurement, but only by simultaneous direct measurements of distance and time; much less are we given the rate of change of speed. The beginner has no real experience with acceleration as a measurable quantity; it is the rate of change of a rate of change, and too abstract for most people. It does have a connection with effort; to throw a ball fast is harder than to throw it slow; but I doubt if the average beginner ever has gone beyond that—and certainly many a student of calculus never connects this rough experience with d^2x/dt^2. In fact, we can not get differential expressions by measurement; Kepler's planetary laws and Galileo's laws of falling bodies are either integral expressions representing their tables of length[1] and time measurements, or are deduced from these integral expressions. Beginners do not of their own accord take the trouble to construct such tabulations or to differentiate twice the resulting integral expressions; in fact, few can do this, or at first realize what it all means when they are made to do it.

Our most continuous effort is to keep ourselves or other objects off the ground; the next most familiar, to set objects in motion upward, a motion which, unless some obstacle prevents, is sooner or later reversed into a motion downward. We say, as if an antagonistic effort were opposing ours, that the earth exerts a downward force upon us and all things near it; it is able to change their forms or to set them in motion downward.

While our sensations of effort are only qualitative, telling us of more and less, but not of how much, we assign measure to this earth effort, or force, or weight, by saying that its

[1] Angles are measured by arcs of graduated circles.

size is twice as great when it pulls on two exactly like objects together as it is when it pulls on only one of them; and conversely we use this pull to measure the elastic force of a spring, the relative magnitudes of different bodies, etc. This notion, that the magnitude of earth pull is proportional to the number of otherwise equal things on which it acts, is fundamental, and so familiar as to seem axiomatic; it is instinctive, as E. Mach would say.

The study of the downward motion of bodies affected by their own weight and only slightly by friction was a lifelong interest of Galileo. Directly or indirectly he showed two things; that they fall equal distances in equal times, and that unequal distances of fall are proportional to the squares of the times of fall. Differentiation of the latter showed that the gravitational acceleration is constant during the time of fall; the former showed it to be the same for all things, independently of their weight or material.

The last conclusion leads to an appreciation of another difficulty in the study of mechanics, if we take into account a law of psychology, well stated in the following quotation from William James:

. . . any number of impressions, from any number of sensory sources, falling simultaneously on a mind which has not yet experienced them separately, will yield a single undivided object to that mind. The law is that all things fuse that can fuse, and that nothing separates except what must.

The singling out of elements in a compound. It is safe to lay down as a fundamental principle that any total impression made on the mind must be unanalyzable so long as its elements have never been experienced apart or in other combinations elsewhere. The components of an absolutely changeless group of not-elsewhere-occurring attributes could never be discriminated. If all cold things were wet, and all wet things cold, if all hard things pricked our skin, and no other things did so: is it likely that we should discriminate between coldness and wetness, and hardness and pungency, respectively? If all liquids were transparent and no non-liquid were transparent, it would be long before we had separate names for liquidity and transparency. If heat were a function of position above the earth's surface, so that the higher a thing was the hotter it became, one word would serve for hot and high. We have, in fact, a number of sensations whose concomitants are invariably the same, and we find it accordingly impossible to analyze them out of the totals in which they are found.

Now to lift a stone vertically we have to exert an effort, neutralizing the earth's pull upon it, its weight. To throw the same stone horizontally, to accelerate it, we have also to exert effort; and the harder the stone is to lift, the harder it is to throw. (If we refine this crude observation by experiment, we find an exact proportionality between the weights of objects and the efforts or forces required to accelerate them equally.) Hastily generalizing, but most naturally, we say that stones are hard to throw, gates hard to swing, not in proportion as, but *because* they are heavy. To ordinary observation the accelerating and the gravitational efforts always increase and decrease exactly together; they do not tend to become discriminated, we do not abstract them separately.

To exact observation, however, a difference does show itself. The same stone weighed in a spring balance would elongate the spring less in low latitudes than in high (we tell our classes this; did any one ever try it?). The same pendulum vibrates more slowly in low latitudes than in high, as Richer found in 1672–3. We can imagine a man lifting and throwing a ball at the bottom and again at the top of a tower four thousand miles high, observing a notable change in the weight of the ball and yet none at all in the difficulty of throwing it. But such observations under terrestrial conditions have to be accurate to less than ½ per cent., far more accurate than the unaided sense memory can be. To the average man a heavy thing is also hard to throw, because it is heavy; a fact which stands as a formidable obstacle to a clear grasp on the idea of mass; to most students mass and weight are forever identical, except that the book says to divide weight by g to get mass.

In an old copy of Wells' "Natural Philosophy" I find the following problem and answer, which may serve as an illustration:

Why will a large ship, moving toward a wharf with a motion hardly perceptible, crush with great force a boat intervening?

Because the great mass and weight of the vessel compensates for its want of velocity.

Which shows that the author of this famous book did not discriminate between mass and weight in a case where weight as force does not enter.

This confusion of mass and weight can not be helped by pseudo-definitions which attempt to evade the essentially kinetic nature of the mass concept. As is well known, Newton, in the "Principia," defined mass as the product of density and volume, and equivalent to quantity of matter. Neither of these statements has any value, as neither brings out the essential fact that a body subject to acceleration displays a constant characteristic property, which is the core of Newton's own treatment of the problem of accelerated motion. Another more recent definition states that mass is the result obtained by weighing with a balance scale. This can not help a student very much. The balance scale was known for centuries before Newton, and had mass been so easily defined it would hardly have been left for him to discover the fact of its existence and importance. The fact is, that mass is a concept of kinetics, not to be reached at all by static experiments, and not to be clearly discovered by kinetic experiments affected by friction. It came into science by way of Mars and the moon, and was then read into terrestrial experience. The "balance scale" gives us mass not directly, but by interpretation, even as does the Jolly balance. It is not always true that "in physics sensible people define things the way they do them."

Students in general seem to have no serious difficulty with the equality of push and counter-push, of friction and counter-friction, of action and reaction. Trouble does come up in the identification of actions and reactions, and in the realization that these always act upon different things, in opposite directions in the same straight line.

As illustrations, take two quotations, the first from Wells's "Natural Philosophy," of the sixties, the other from a recent book:

The centrifugal force is that force which impels a body moving in a curve to move outward or fly off from a center. The centripetal force is that force which draws a body moving in a curve toward the center, and compels it to move in a bent, or curvilinear course. In circular motion the centrifugal and centripetal forces are equal, and constantly balance each other. If the centrifugal force of a body revolving in a circular path be destroyed, the body will immediately approach the center; but if the centripetal force be destroyed, the body will fly off in a straight line, called a tangent.

Suppose the horse drawing a sled increases his speed. Two reactions now oppose the pull applied to the sled. One, friction, opposes the slipping of the sled over the ground; the other, due to inertia, opposes increase of speed. These two together are equal and opposite to the pull exerted on the sled.

These are only cases of confusion such as come up in every physics or mechanics classroom; centrifugal and centripetal forces balancing each other in circular motion, both acting on the same thing; friction and the "vis inertiæ" are the reactions to the pull exerted by a horse.

When one has endeavored to point out the nature of a difficulty, it is natural to ask him for the remedy. I am not pretending that I have found remedies for the difficulties mentioned above, some of which seem to be imposed upon us by the constitution of our minds and the environment in which the race has grown up. The only thing to do is to make every endeavor to break up the satisfaction of the student with the concepts which he has unconsciously formed, to try to contrive striking experiments which shall, for example, make plain that something more than the notion of weight is needed for their explanation, and, especially, to familiarize him with the concept acceleration and the various ways of arriving at its value, theoretically and practically. The teacher has almost to strive against instinct in the treatment of the laws of motion, and some people can never be expected to grasp them.

WILLARD J. FISHER

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THE TEACHING OF ELEMENTARY DYNAMICS

TO THE EDITOR OF SCIENCE: The communication of Professor Wm. Kent in SCIENCE of December 24, 1915, on the subject heading is particularly interesting as a critical analysis, but the writer does not think Professor Kent's proposed method of teaching the subject is the best way.

As further discussion is invited, a method will now be given, very briefly, that is clear and brief and that beginners readily comprehend.

1. Let a *spring-balance* be graduated with a set of standard pound weights (metal pieces) at sea level, say at latitude 45°, where $g = 32.174$ ft. per sec. per sec. is the acceleration due to gravity. Now suppose a certain body there, when hung from the spring-balance, to depress the pointer until it reads W pounds; then the pull of the earth at this point on the body is exactly W pounds force.

2. Let the same body be hung from this same spring-balance *at any other point* where the acceleration of gravity is g_1 and suppose the pointer reads W_1 pounds; then the pull of the earth on the body at the second place, is W_1 pounds force.

3. State as an experimental fact that

$$W_1/g_1 = W/g. \qquad (1)$$

This simple equation gives the solution to a number of problems involving weights as measured on the standard spring-balance at different latitudes and altitudes. Give several of these problems.

4. *Mass.*—Mass of a body means the quantity of matter in the body. It is not supposed to alter in amount by changing the position of the body relative to the earth or to be affected by chemical changes, the expansion or contraction of the body or by any change of the body from a solid to a liquid or gaseous state or a reverse change.

If the body weighs W pounds on the standard spring-balance at the place where the acceleration of gravity is g ft. per sec. per sec., the mass of the body will be assumed to vary with W/g, which is likewise unaltered, by eq. (1), by any change of place, volume or condition. If M denote the numerical measure of the mass of the body in question, we can write,

$$M = k\ W/g,$$

where k is a constant for any chosen set of units. For the engineer's system, $k = 1$ and,

$$M = W/g. \qquad (2)$$

We have now a precise numerical measure of the mass of a body and observe that, at the same place, the mass of a body is directly proportional to its weight. It is not affected by a change of place, by any chemical changes within the body or by any alteration in volume. The student has now a clear-cut, definite idea of the mass of a body and of its measure in the engineer's system. When $W = g$, $M = 1$; hence the unit of mass is the quantity of matter that weighs g lbs. on the spring balance at the place where the acceleration is g.

If W is the spring-balance weight at sea level, 45° latitude, where $g = 32.174$, then $M = W/32.174$ and the unit of mass is the quantity of matter in a body weighing 32.174 lbs. on a spring-balance at sea level, 45° latitude or 32.174 lbs. on a lever balance anywhere.

5. Mass is a fundamental concept and being clearly understood, "*density*" can be defined, for a homogeneous body, as the ratio M/V, where V is the volume of the body of M units of mass.

6. From eq. (2), we have,

$$W = Mg. \qquad (3)$$

Now if an unbalanced force of F lbs., acting on a body of M units of mass, produces in it an acceleration of a ft. per sec. per sec., the formula giving the relation between F, M and a must reduce to (3) when $F = W$, $a = g$.

Such a formula is

$$F = Ma. \qquad (4)$$

This is one of the fundamental formulas of mechanics and the arguments in favor of it should be given as fully as possible, somewhat as in Routh's "Dynamics of a Particle," pp. 18–23 and in connection with Newton's "Three Laws of Motion." The formula is equivalent to the second law, of which the first is a corollary. The formula is readily verified by use of Atwood's machine when $a < g$.

7. From (4), other well-known formulas, $Ft = Mv$, $Fs = \frac{1}{2}Mv^2$, etc., can at once be de-

rived; also by aid of (4) and Newton's third law, that "action and reaction are always equal and contrary" the problem of impact of two particles can be solved.

8. By pursuing the course outlined above, the student has to learn and thoroughly understand, only two simple formulas, $M = W/g$, $F = Ma$.

WM. CAIN

CHAPEL HILL, N. C.

GRAVITATION AND ELECTRICAL ACTION

IN a paper to be published by the Academy of Science of St. Louis, evidence will be presented which appears to show conclusively, that gravitational attraction is diminished by electrical charges on the acting masses. The suspended masses of the Cavendish experiment are wholly enclosed in a shield of sheet metal. The small observation window is covered with wire gauze. When a knob terminal connected with the influence machine is moved towards or away from a knob terminal connected with the large attracting masses, the suspended masses slowly move to and fro around the vertical line of suspension. No disruptive discharges occur. It is found that gravitational attraction is decreased by either positive or negative electrification. By the to-and-fro movement of the knob terminal, the amplitude of vibration can be gradually increased from 2.5 minutes of arc to 50 minutes. It has been established by experimental methods that these results are not due to heat effects.

FRANCIS E. NIPHER

THE PRODUCTION OF RADIUM

TO THE EDITOR OF SCIENCE: On page 799 of the June 2, 1916, issue of SCIENCE a statement is made in regard to the production of radium by the Standard Chemical Co. in the year 1915, which is not in accord with facts, and I wish to make this correction. The actual amount of radium produced by the Standard Chemical Co. during 1915 was slightly more than 8 grams of radium element and of this the larger proportion was produced in the first three months of the year from radium which was in process of treatment during the latter part of 1914.

In this same article the production of radium at a cost of $37,599 per gram by the National Radium Institute Inc. working in cooperation and under the supervision of the Bureau of Mines, is compared with the market price of radium of $120,000 a gram. The radium produced by the National Radium Institute was obtained from high-grade carnotite ore treated without concentration, and the cost of production under these conditions is not properly comparable to the cost of production or the selling price of radium from lower grade ore or concentrates.

Applying the Bureau of Mines process to unconcentrated ore containing about 1.5 per cent. of uranium oxide (which is higher than the average carnotite ore) makes the cost of production nearer $70,000 than $40,000 per gram. Since this is practically the condition under which commercial producers of radium must operate, it would be fairer to compare cost of production by the Bureau of Mines process on this basis, rather than on the basis of the uncommercial and somewhat artificial conditions, connected with the treatment of the 1,000 tons of high-grade ore. Concentration of the low-grade ore, if practised, naturally reduces the efficiency of extraction, and in this way would raise the cost of production.

While it is true that the war cut off practically the entire European market to radium producers, it must be added that the growing American market for radium has been very adversely influenced by the widespread publishing of statements, from the United States Bureau of Mines, similar to the statement in SCIENCE which we are criticizing. The general effect of these statements has been to lead prospective purchasers of radium to believe that radium would soon be available at enormously reduced prices. Emphasis being laid by the Bureau of Mines on the exceptionally low cost of production, and in general no mention being made of the fact that this low cost of production was in a large measure due to the abnormal and uncommercial conditions under which the Bureau operated.

As regards ore concentration it is also interesting to note that the method used by the Bureau of Mines is one which has been used

by the Standard Chemical Company for the past four and a half years, and on the basis of figures published by Dr. Charles L. Parsons in the May number of the *Journal of Industrial and Engineering Chemistry,* it is not evident that the method is satisfactorily efficient, when applied to the treatment of low-grade carnotite ore.

CHARLES H. VIOL

PITTSBURGH, PA.,
June 3, 1916

SCIENTIFIC BOOKS

RECENT BOOKS IN MATHEMATICS

Algebraic Invariants. By LEONARD EUGENE DICKSON, Professor of Mathematics, University of Chicago. New York, John Wiley and Sons, 1914. Pp. 100. $1.25.

A Treatise on the Theory of Invariants. By OLIVER E. GLENN, Ph.D., Professor of Mathematics in the University of Pennsylvania. Boston, Ginn and Company, 1915. Pp. 245.

Contributions to the Founding of the Theory of Transfinite Numbers. By GEORG CANTOR. Translated and Provided with an Introduction and Notes by PHILIP E. B. JOURDAIN. Chicago and London, The Open Court Publishing Company, 1915. Pp. 211. $1.25.

Problems in the Calculus. With Formulas and Suggestions. By DAVID D. LEIB, Ph.D., Instructor in Mathematics in the Sheffield Scientific School of Yale University. Boston and New York, Ginn and Company, 1915. Pp. 224.

Diophantine Analysis. By ROBERT D. CARMICHAEL, Assistant Professor of Mathematics in the University of Illinois. New York, John Wiley and Sons, 1915. Pp. 118.

Historical Introduction to Mathematical Literature. By G. A. MILLER, Professor of Mathematics in the University of Illinois. New York, The Macmillan Company, 1916. Pp. 295.

An invariant is any thing—a property or a relation or an expression or a configuration—that remains unaltered when other things connected with it suffer change. In this very comprehensive but essential meaning of the term, the notion is probably as ancient as the human intellect. Certainly in historic time the appeal of the idea has been universal. It has been said that science may be defined as the quest of invariance. Doubtless that quest is an essential mark of science but it is not peculiar to science. For the problem of invariance, the problem of finding permanence in the midst of change, arises out of the flux of things to confront man in all departments of life. And so it is that the search for what abides is not confined to science but is and always has been the chief enterprise of philosophy and theology and art and jurisprudence. It is, however, in mathematics that the notion of invariance has come to the clearest recognition of its character and significance. In this respect the notion in question has had a history like that of all other great ideas that have slowly and at length become available for the processes of logic.

The oldest and now most elaborate portion of the mathematical doctrine of invariance is about as old as American independence. Though now an imposing theory, its beginning was like a mustard seed. It began, not in ratiocination, but in an observation—mathematics indeed depends even more upon observation than upon formal reasoning. It began in what was in itself a very small observation, an observation (1773) by Lagrange that the discriminant of the quadratic form $ax^2 + 2bxy + cy^2$ remains unaltered on replacing x by $x + \lambda y$. The next important step was taken by Gauss in 1801 and the next by Boole in 1841. Incited by Boole's beautiful results, the English mathematicians, Cayley and Sylvester, entered the field, the former producing in rapid succession his great memoirs on Quantics and the latter his brilliant investigations in what he conceived more poetically as the Theory of Forms. The interest so aroused quickly passed to the continent engaging the great abilities of such mathematicians as Aronhold, Hermite, Clebsch, Gordan and others. The result is the colossal doctrine variously styled the algebra of quantics, the theory of algebraic invariants and covariants, and the theory of forms.

It is to this doctrine that Professor Dick-

son's book gives the beginner an admirable introduction. It is, I say, for beginners, for it presupposes only a fair knowledge of analytical geometry and the differential calculus. The book is much larger than it appears to be, being very compactly written, the author having the art of getting a maximum of results with a minimum of talk. Yet the exposition is remarkably clear, uniting the two stylistic virtues of precision and conciseness. The work is composed of three parts. The symbolic notation is reserved for part III. Geometric interpretation is emphasized. In part I. linear transformation is alternately interpreted non-projectively and projectively; that is, on the one hand as working a change of reference configuration, and on the other as merely effecting a lawful transfer of attention from old loci (or envelopes) to new ones referred to the old configuration. Part II., which is mainly concerned with the properties of binary forms, deals with such matters as homogeneity, weight, transformation products, annihilators, linear independence, Hermite's reciprocity law, etc. The canonical form of the quartic is found and the equation is solved. Part III., which occupies 38 of the book's 100 pages, is devoted to a presentation and use of the symbolic method of Aronhold and Clebsch. In passing the author notes that this method is equivalent to the previously invented but relatively cumbrous hyperdeterminant method of Cayley. This part and indeed the book may be said to culminate in Hilbert's theorem regarding the expressibility of the forms of a system in terms of a finite number of them and the use of the theorem in proving the finiteness of a fundamental system of covariants of a set of binary forms.

It seems unfortunate that Professor Dickson did not deem it wise or find it practicable to set forth the matter of this volume in its natural relation to the theory of groups. Perhaps some one will some time write for beginners a book on transformations, groups and invariants with applications.

Professor Glenn's treatise is somewhat more extensive than Professor Dickson's. It, too, is introductory, beginning with a variety of simple considerations. Both the symbolic and the non-symbolic methods are explained and employed. Geometric interpretations are given and some connection with the group concept is made. The book comprises the following nine chapters: the principles of invariant theory (32 pages); properties of invariants (7 pages); the processes of invariant theory (40 pages), dealing with operators, the Aronhold symbolism, reducibility, concomitants in terms of roots, and geometric interpretations; reduction (46 pages), concerned with Gordan's series, the quartic, transvectant systems, syzygies, Hilbert's theorem, Jordan's lemma, and grade; Gordan's theorem (16 pages), giving proof of the theorem and illustration by the cubic and quartic; fundamental systems (16 pages); combinants and rational curves (13 pages); seminvariants and modular invariants (32 pages); and invariants of ternary forms (25 pages). There is added an appendix of ten pages devoted to exercises.

With access to the foregoing books, to Salmon's classic book, and to such recent British works as that by Grace and Young and Elliott's "Algebra of Quantics," the English-speaking student can not complain of having to resort to other languages for a knowledge of this classic branch of modern algebra.

Many readers, including mathematicians and philosophers, will be grateful to Mr. Jourdain for his excellent translation of Cantor's famous memoirs of 1895 and 1897. These were published in the *Mathematische Annalen* under the title, "Beiträge zur Begründung der transfiniten Mengenlehre." The translator's rendering of the title is justified by the content of the memoirs. This content is not likely to be fully intelligible to any but such as have mastered Cantor's earlier works beginning in 1870. The value of the volume is much increased by the translator's Introduction of 82 pages sketching the development of function theory in the course of the last century and by the notes he has appended dealing with the growth of the theory of transfinite numbers since 1897.

Dr. Leib's collection of problems presents a good list under each important theme dealt

with in a first course in the calculus. But few of the problems have been worked out fully and the devising of geometric figures has been left to the student under the guidance of the text he is using or of his instructor, but numerous cautionary and directive explanations are given clearly and concisely, usually at the beginnings of the various problem lists. The answers to typical exercises of each list are given, but a large percentage of the problems are unanswered. Such a collection of exercises ought to make it practicable to teach the elements of the calculus by means of lectures or by means of thin books confined mainly to a presentation of theory.

There are two special reasons why the appearance of Professor Carmichael's beautiful book should be noted in this journal. One is that the subject treated has made a most extraordinary appeal in all scientific times and places. With the exception of geometry, astronomy and logic, hardly any other technically scientific subject has better served to tie together so many centuries, for interest in it probably antedates the school of Pythagoras. The second reason is that a certain long-outstanding problem of Diophantine analysis has recently come to very popular fame by virtue of the extraordinary prize of $25,000 provided by the German mathematician Wollfskehl for its solution. The problem is to prove the so-called Last Theorem of Fermat (1601–1665) stated by him without proof on the margin of a page of his copy of a fragment of the "Arithmetica" of the Greek mathematician Diophantos. The theorem is: *If n is an integer greater than 2 there do not exist integers x, y, z, all different from zero, such that* $x^n + y^n = z^n$. The prize, the offer of which does not expire till September 13, 2007, will be awarded to one who proves that the theorem is not universally true (if it is not) and who at the same time determines all values of n for which it is true. Long before the prize was announced the problem engaged the efforts of great mathematicians and thus led to important developments in the theory of numbers. Since the announcement thousands of the mathematically innocent have assailed the problem. If these innocents could have had access to such a book as Professor Carmichael's where the nature of the problem is explained and the present state of knowledge regarding it is sketched, they might have been deterred from wasting their time and that of others.

The rendering of such a service was not, however, the author's aim. There is scarcely another branch of mathematics in which the results achieved in course of the centuries are so special, fragmentary and isolated. Professor Carmichael's aim was two-fold, namely, to produce for beginners an introduction to Diophantine analysis and to bring its fragmentary and scattered discoveries into organic unity. And he has succeeded admirably. The style is excellent. The content and scope of the book are fairly well indicated by the titles and lengths of its six chapters: Introduction, rational triangles, the method of infinite descent (22 pages); problems involving a multiplicative domain (30 pages); equations of third degree (20 pages); equation of fourth degree (10 pages); higher equations, the Fermat problem (17 pages); the method of functional equations (9 pages). The theory thus actually presented and the judiciously selected exercises make the work available for private reading as well as for a short university course in the subject.

Professor Miller's "Historical Introduction to Mathematical Literature" grew out of a course of lectures designed to supplement regular instruction. It thus employs a more or less expansive style and seeks to be "synoptic and inspirational" for such as may not lay claim to much mathematical discipline. It is guided by a highly commendable aim: namely, to conduct the reader to commanding points of view so that he may judge for himself whether the fields he is thus enabled to glimpse invite him to further exploration. The aim is pursued with a notable optimism despite the nation-wide depreciatory utterances of such educational leaders and agitators as Commissioner Snedden and Abraham Flexner. Professor Miller believes that "shameless ignorance" of mathematics "does not represent a

normal condition on the part of those interested in the history of the human race." We are also told that "with our gradual evolution from the state of barbarism the history of war and bloodshed is being slowly replaced by that of political and intellectual movements." From which we infer that that portion of the preface was composed prior to August, 1914.

Believing that history courses for secondary-school teachers should be more largely concerned with modern developments than is their wont, Professor Miller particularly stresses these developments, though the content of his discourse is in very considerable measure drawn also from ancient and medieval times.

The 35 pages of the initial chapter are devoted to sketching the progress made from the beginning of the nineteenth century to the present time in mathematical intelligence, mathematical research, mathematical history and mathematical teaching. In particular the fact is pointed out that the rapid and continuously increasing American mathematical activity during the last twoscore years has placed our country among the leading mathematical countries of the world. If we have not yet produced a mathematician of the very first rank, we can at least claim to have produced men of notable ability and productiveness.

Chapter II. (42 pages) presents a large amount of interesting information respecting types of recent literature, societies, international congresses, periodicals, works of reference, mathematical tables and collected works. In the 51 pages of the third chapter we have a rather meager discussion of definitions of the term mathematics; a historical account of the manner in which the science has acquired its grand divisions and subdivisions; a quite too brief but interesting account of the advent, influence and position of a few "dominant concepts" such as irrational quantities, equation solution, function, group, matrix, domain of rationality; some instructive remarks and historical references respecting mathematical terminology and notation; a short section on errors in mathematical literature; a section, entitled living mathematicians, arguing with feeling and good judgment the importance of devising suitable means for determining "Who is Who" among mathematicians; and a final section treating inadequately, hardly more than touching, the now pressing question of mathematics as an educational subject.

There follow three chapters dealing with "fundamental developments" respectively in arithmetic, in geometry and in algebra. Of these the first (29 pages) opens with Euclid's proof that the number of prime numbers is infinite; explains the Sieve of Eratosthenes; sketches the history and appraises the significance of irrational numbers, giving (doubtless unintentionally) the impression (p. 133) that these numbers admit of only negative definition; treats briefly the fundamental operations of arithmetic, then of notation systems, and closes with a short and excellent account of the Fermat theorem. The next chapter (23 pages) devotes to "fundamental developments in geometry" three sections, one to the Pythagorean theorem, one to the area and volume of the sphere, and one to the triangle. A valuable chapter (22 pages) on algebra is historically rich in its handling of the fundamental theorem of algebra, the notion of determinant, numerical equations, domains of rationality, the beginnings of invariant theory, and the tale of the binomial theorem.

Chapter VII., somewhat oddly entitled "Twenty-five Prominent Deceased Mathematicians," is the largest and most interesting division of Professor Miller's interesting book. It contains a very readable account of the following men selected from among the great mathematicians of the world: Euclid, Archimedes, Apollonius, Diophantus, Vieta, Descartes, Fermat, Newton, Leibniz, Euler, Lagrange, Gauss, Cauchy, Steiner, Abel, Hamilton, Galois, Sylvester, Weierstrass, Cayley, Hermite, Kronecker, Cremona, Lie, Poincaré.

The book closes with a list, accompanied with brief characterizations, of a large number of bibliographies, reference works, and books on the history, and the teaching and philosophy of mathematics.

CASSIUS J. KEYSER

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The Mental Life of Monkeys and Apes: A Study of Ideational Behavior. By ROBERT M. YERKES. New York, 1916. Pp. 145.

This monograph reports the results of admirable experiments on two monkeys and an orang-utan, first, by the multiple-choice method of Yerkes, and second, by various forms of the mechanical-adaptation method. It also presents a plan for a research institute for the study of the primates.

The multiple-choice method is a means of diagnosing and measuring an animal's ability to respond correctly to relations of spatial order, such as *middle door of those open,* or *right-hand door of those open,* regardless of the number of doors that are open or which doors (of the entire nine possible to be open) they are. Food was used as a reward for entering the right door, and, irregularly, detention in a box as a punishment for entering the wrong door.

The first problem was to learn to enter at once the first door at the left end of whatever doors were open. The following summary for one monkey will give an idea of the sort of facts obtained. In the course of 150 trials the per cent. of successes rose from 30 to 90, for the ten selections of doors open that were employed. In a test with one trial each of ten still different selections of doors the number of successes was 6. The monkey did not seem to learn by a "free idea" of "*door at left end*"; for each selection of doors seemed to be responded to by itself. 8 as the response to 8–9, 6 as the response to 6–7–8, 4 as the response to 4–5–6–7–8, 7 as the response to 7–8–9 and 5 as the response to 5–6–7 were apparently learned at a time when 1 as a response to 1–2–3, 3 as a response to 3–4–5–6–7 and 2 as a response to 2–3–4–5–6, were not. There was no sudden elimination of wrong responses. "Stupid" responses appeared in connection with the general behavior in the test.

As a result of four such series of experiments with one monkey and three with another, Yerkes concludes that "the *Pithecus* monkeys yielded relatively abundant evidence of ideation but with Thorndike I must agree that of 'free ideas' there is scanty evidence, or rather, I should prefer to say, that although ideas seem to be in play frequently, they are rather concrete and definitely attached than 'free.' Neither in my sustained multiple-choice experiments nor from my supplementary tests did I obtain convincing indications of reasoning. What Hobhouse has called articulate ideas I believe to appear infrequently in these animals. But on the whole, I believe that the general conclusions of previous experimental observers have done no injustice to the ideational ability of monkeys."

The orang-utan seemed to get "an idea of" *left-end-door of those open* and use it to guide his responses. He did not, however, apparently get the idea of *next-to-the-right-end-door* in 1,380 trials. Various phases of his behavior, however, convinced Yerkes that he was responding to ideas or representations of experience.

In the miscellaneous tests the orang-utan showed great pertinacity and initiative. On the whole "the orang-utan is capable of expressing free ideas in considerable number and of using them in ways highly indicative of thought-processes, possibly even of the rational order. But contrasted with that of man, the ideational life of the orang-utan seems poverty-stricken."

The experiments with the monkeys and the ape are described with the author's customary care and will be of service in many ways to future workers in this field. For example, they bear directly on the Smith-Watson-Carr doctrine that frequency of connection, irrespective of the consequences of the connection to the animal, is adequate to account for learning. Cases abound in the records where a certain wrong door is in the first few trials chosen far oftener than the right door and yet eventually is never chosen. The multiple-choice experiments should be widely used in studies of both animal and human learning.

The last division of the monograph presents Yerkes' proposal for the provision of a special institute for studying the monkeys and apes. Porto Rico and Southern California are suggested as satisfactory localities. The indirect value of such an institute for human

betterment is emphasized as well as its direct value in the advancement of knowledge, and strong claims are made for its support.

It certainly is the case that animal psychology in this country has, in the past decade, done very solid and instructive work with very little financial support from universities or research funds. The experiments here reported represent a gift of the time of one man of science and a gift of material resources from another. They are typical of the scientific devotion and self help which the public can profitably reward by any means in its power, and which any individual honors himself by supporting.

Edward L. Thorndike

Teachers College,
Columbia University

RETROGRESSION IN AMERICAN LONGEVITY AT ADVANCED AGES

It is generally suspected among a limited group of scientific men that although we seem to be improving in matters of health we are doing so in spite of adverse conditions at the more advanced ages.

We have certainly improved on the whole, for the area in the United States from which acceptable records in mortality statistics are received annually (the registration area) has doubled in the number of states included, within the past decade (1900–1910), although it is still no more than half of the total number of the states of the Union, to the shame of such great states as Illinois, Iowa, Kansas, Nebraska, etc. That mortality conditions have improved in the neighborhood of the age of birth and in fact, at all the earlier ages, is so well established that it needs no comment. Also, the general death rate in this country has decreased more in the past decade (2.6) than in the previous two decades taken together (2.2).

But all this improvement is too deceiving; it covers up the fact that in some respects we are worse off now than we were twenty years or more ago. Stated concretely we expect to show in this paper that individuals between the ages of about 50 and 75 do not, on the average, live as long now as they did twenty years ago; and the extent of this retrogression is increasing. We shall refer to this period or interval of ages as the Period of Retrogression.

We hope to point out also slight indications of tendencies to "come back" at the still more advanced ages, say from 75 on. That the individuals at these extreme ages are "coming back" seems pretty firmly indicated by the results of this investigation, but not only is the "come back" small but it is also manifested at ages where statistical data are faulty; hence, we recommend that these indications be held in abeyance until they are more clearly verified by other investigations of similar nature.

The English statistician and actuary, Mr. George King, has explained a short method of constructing abridged mortality tables wherein only representative portions of the tables and the corresponding death rates and expectations of life are given. We have utilized this method to construct six abridged mortality tables based upon the mortality statistics of each of the sexes, and for the three single years 1890, 1900, and 1910. The year 1880 was not included because the population data and mortality statistics for that year which were reliable do not cover exactly the same area. The mortality statistics of all years previous to 1880 are worthless for our purpose. The essential purpose of this paper is to compare and discuss the results obtained through the construction of these mortality tables.

The fact that each mortality table is constructed from data covering but a single year absolutely prohibits the use of such tables except to point out general conclusions such as are indicated in this paper. Our attitude in this matter should not be forgotten.

As the explanation of the method of construction of the tables is technical and has no special bearing upon the interpretation of the final results, we shall merely refer the reader who desires further information to Mr. King's explanation—which, however, will bear much simplification—in the Registrar General's report for 1914.

The statistical data for the year 1890 com-

prise the population and deaths of the nine registration states of that year: Connecticut, Delaware, Massachusetts, New Hampshire, New Jersey, New York, Rhode Island, Vermont, and the District of Columbia. The statistics of the years 1900 and 1910 which were used in this investigation comprise those of the same states enumerated above, except Delaware, and of the states Indiana, Maine and Michigan.

The mortality tables were completed at the extreme and relatively unimportant ages not covered by reliable data, in the rather arbitrary manner discussed by Mr. King.

The abridged mortality tables are given here for visual comparison, but our discussion will be directed solely to the death rates and expectations of life given later.

MORTALITY TABLES

	1890		1900		1910	
Ages	Males	Females	Males	Females	Males	Females
12	100,000	100,000	100,000	100,000	100,000	100,000
17	98,026	97,715	98,390	98,182	98,537	98,678
22	94,558	94,613	95,596	95,466	96,281	96,665
27	90,219	90,793	92,115	92,066	93,487	94,089
32	85,655	86,559	88,414	88,379	90,344	91,220
37	80,876	82,122	84,450	84,594	86,618	88,036
42	75,777	77,484	80,108	80,625	82,281	84,485
47	70,309	72,670	75,247	76,289	77,246	80,445
52	64,259	67,318	69,998	71,206	71,394	75,532
57	57,290	61,084	63,556	64,932	64,260	69,204
62	49,359	52,181	55,178	57,292	55,255	61,098
67	40,571	43,990	45,167	48,036	44,707	50,974
72	31,000	34,582	33,670	36,844	32,651	38,674
77	20,826	24,192	21,806	24,707	21,358	25,362
82	11,308	14,022	11,151	13,372	11,643	13,677
87	4,579	6,244	4,013	5,240	4,212	5,678
92	1,388	1,976	898	1,347	1,068	1,671
97	339	464	108	198	227	316
102	68	84	6	14	40	34
107	11	12	0	0	6	2
	0	1			0	0

It is to be noticed that the ages in the neighborhood of the age of birth are ignored. This is practically necessary in the use of such short methods, considering the great variations in death rates at the ages of this period. However, examination of various mortality tables constructed upon mortality conditions in the United States will reveal little difference between the expectation of life at age twelve and that at the age of birth. Thus, the expectation of life at age twelve is a fair estimate of the average length of the whole of American life, especially when used for purposes of comparison of two or more sets of mortality conditions.

The abridged list of death rates and corresponding differences are as follows:

DEATH RATES PER 100,000

Males

Ages	1890	Diff.	1900	Diff.	1910
12	331	− 55	276	− 39	237
17	546	− 64	482	− 89	393
22	864	− 165	699	− 141	558
27	1,015	− 230	785	− 156	629
32	1,065	− 196	869	− 98	771
37	1,260	− 273	987	− 40	947
42	1,358	− 204	1,154	− 7	1,147
47	1,696	− 313	1,383	+ 50	1,433
52	1,961	− 306	1,655	+ 152	1,807
57	2,757	− 283	2,474	+ 99	2,573
62	3,277	+ 53	3,330	+ 311	3,641
67	4,781	+ 159	4,940	+ 120	5,060
72	6,172	+ 874	7,046	+ 597	7,643
77	10,075	+ 475	10,550	+ 738	11,288
82	13,893	+1,967	15,860	− 628	15,232
87	20,324	+2,344	22,668	+ 25	22,693
92	23,384	+7,475	30,859	−5,332	25,527

Females

Ages	1890	Diff.	1900	Diff.	1910
12	382	− 70	292	− 69	223
17	574	− 92	482	− 135	347
22	745	− 77	668	− 165	503
27	924	− 133	791	− 206	585
32	987	− 143	844	− 176	668
37	1,136	− 217	919	− 146	773
42	1,195	− 169	1,026	− 125	901
47	1,417	− 181	1,236	− 123	1,113
52	1,705	− 97	1,608	− 104	1,504
57	2,281	− 84	2,197	− 65	2,132
62	2,846	+ 118	2,964	+ 72	3,036
67	4,207	+ 138	4,345	+ 145	4,490
72	5,637	+ 928	6,565	+ 305	6,870
77	8,988	+ 663	9,651	+ 437	10,088
82	12,610	+1,106	13,716	+ 464	14,180
87	18,496	+2,367	20,863	− 867	19,996
92	23,437	+5,049	28,386	+4,482	32,868

In the table of death rates given above, attention is called not so much to the absolute values and their differences—for the results lack graduation—but rather to the trend of mortality conditions as indicated by them. This trend among both the males and females is unquestionably forward at all ages below 60, except in the decade 1900–1910, in which the advance among the males is terminated at

about age 45. We might go farther and say that for this same decade the males did not advance as much at the ages at which they did advance as they did in the previous decade. On the other hand, the females maintained or even excelled their record of 1890–1900 in the decade 1900–1910.

The most important feature of the table of death rates is the group or period of ages at which both males and females have retrogressed. This retrogression is significant in value wherever indicated, and that it is not due to faulty statistics or errors is clearly shown by the fact that it appears *in both decades in both sexes*. Further, the retrogression is not spasmodic, but continues firmly from about age 60 on to the end of the table.

EXPECTATIONS OF LIFE

Males

Ages	1890	Diff.	1900	Diff.	1910
12	46.30	+2.19	48.49	+ .59	49.08
17	42.18	+2.06	44.24	+ .53	44.77
22	38.63	+1.82	40.45	+ .30	40.75
27	35.37	+1.52	36.89	0	36.89
32	32.12	+1.21	33.33	− .24	33.09
37	28.86	+ .91	29.77	− .37	29.40
42	25.64	+ .60	26.24	− .42	25.82
47	22.43	+ .35	22.78	− .45	22.33
52	19.30	− .01	19.29	− .34	18.95
57	16.34	− .35	15.99	− .29	15.70
62	13.56	− .54	13.02	− .10	12.92
67	10.94	− .60	10.34	+ .02	10.36
72	8.54	− .54	8.00	+ .26	8.26
77	6.49	− .49	6.00	+ .33	6.33
82	4.51	− .07	4.44	+ .15	4.59
87	3.73	− .48	3.25	+ .34	3.59
92	2.79	− .51	2.28	+ .76	3.04

Females

Ages	1890	Diff.	1900	Diff.	1910
12	47.90	+1.56	49.46	+1.83	51.29
17	43.96	+1.36	45.32	+1.62	46.94
22	40.31	+1.23	41.54	+1.32	42.86
27	36.90	+1.08	37.98	+ .98	38.96
32	33.58	+ .88	34.46	+ .65	35.11
37	30.26	+ .63	30.89	+ .40	31.29
42	26.92	+ .37	27.29	+ .21	27.50
47	23.54	+ .15	23.69	+ .06	23.75
52	20.21	− .01	20.20	− .07	20.13
57	17.00	− .10	16.90	− .17	16.73
62	14.47	− .66	13.81	− .21	13.60
67	11.69	− .71	10.98	− .19	10.79
72	9.18	− .72	8.46	− .05	8.41
77	7.04	− .65	6.39	+ .13	6.52
82	5.37	− .62	4.75	+ .28	5.03
87	4.14	− .61	3.53	+ .33	3.86
92	3.33	− .76	2.56	+ .36	2.92

There are a few widely varying values at the terminal ages, but, as mentioned above, the statistics at these ages are so faulty that little or no interpretation is possible.

Summarizing the results indicated by the table of death rates, mortality conditions seem to have been improved at ages below sixty during the two decades 1890–1900 and 1900–1910 among both the males and the females, steadily so among the females but not so much so among the males. At ages sixty and above, both males and females seem to have retrogressed, particularly the males whose period of retrogression during the decade 1900–1910 began as far back as age 45. This period of retrogression among death rates for both sexes continues steadily toward the last ages of human life.

As indicated in the table of expectations of life given above, the average future life time of males at age twelve seems to have lengthened 2.19 years in the decade 1890–1900 and only .59 of a year in the decade 1900–1910, or 2.78 years in both decades. The gain of only .59 is rather difficult to explain, for even the general death rate suffered a relapse in 1910, and no one seems to know exactly why. It is possible that the fact that the period of retrogression encroached upon the earlier ages might offer at least a partial explanation. The period of retrogression among the expectations of life of the males is seen to begin about age fifty in the decade 1890–1900 and about age thirty in the decade 1900–1910.

That the initial ages of the period of retrogression in both decades precede the corresponding ages in the table of death rates from 10 to 15 years is what might be expected and is really quite important in that it emphasizes the fact that a retrogression in death rates at any period of ages will affect the expectation of life of *all* those living at any earlier ages. The two initial ages, fifty and thirty, mentioned above, differ from earlier ages only in the fact that these are the first ages at which the effect of retrogression at the advanced ages outweighs the effect of improvement at the earlier ages.

The amount of retrogression in the expectation of life of the males rarely exceeds half of a year, but the mere fact that individuals at ages above fifty do not live as long now as they did several decades ago is of tremendous significance. If this period or retrogression could be made to vanish, so much more would the expectation of life at the earlier ages be increased. It would be serious enough if no advance were registered in this period; an actual retrogression amounts to a calamity.

It is very remarkable that the period of retrogression of the males in the decade 1900–1910 ends about age sixty-five and from that age on we notice a tendency to "come back," a tendency not found in the decade 1890–1900. The value of this "come back" is small, it is true, but the values give no indications of uncertainty by interposing occasionally a negative value (a retrogression). Whether this period of advance at the most extreme ages actually exists or not, we shall not presume to say, but the above figures are highly suggestive.

The period of retrogression among the expectations of life of the females also begins about age fifty, but there is quite a difference between the two decades considered. In the decade 1900–1910 the females seem to have overcome to a great extent the retrogression registered in the decade 1890–1900; this fact is not true of the males. Moreover, this period is now restricted to only about twenty years, whereas before it seemed to extend firmly to the end of the table.

Here again, we see evidences of an effort to "come back" appearing at the extreme ages. The fact that this period of "come back" appears among the expectations of life of the females in the same decade (1900–1910) as it does among the males adds strength to the probability of its actual existence.

The casual reader may have wondered how the period of retrogression among the death rates could extend to the end of the table while that of the corresponding expectations of life could end at some age such as 75. This is perfectly possible, for in obtaining the expectation of life at any age we divide the total number of years lived, by the population at that age, and this total number of years may be lessened without decreasing the expectation of life if the population at the given age is also lessened in the proper proportion.

In this paper we have pointed out a great field for work; we have pointed out the exact location of a serious problem. It still remains for others to diagnose the trouble, and that task might well be left to those familiar with the diseases operative at the ages covered by this period of retrogression. However, we dare suggest that far the greater part of the trouble is due to a peculiar state of indifference and ignorance in regard to the ordinary laws of nature, and therefore can be overcome best by a systematic plan of education along lines of elementary hygiene.

Every one knows that few individuals between the ages of thirty and sixty take any constructive forethought for their physical welfare; few carry out any definite plans for regular daily exercise or proper breathing of fresh air. Fewer still have even a fair conception of their own physical make-up or their condition at any particular time; this fact is due likely both to lack of time and to reluctance to face the truth.

One of the best ways to arouse interest in practical hygiene would be through the organization of a National Health League which would hope ultimately to have a representative organization in every large community. It should be the duty of such a body to encourage right living among its members and all individuals associated with them. This work should be supplemented by a systematic and regular program of study and discussion. For local organizations made up of individuals who insist they are too busy to make a personal study of the subject, practical lectures could be arranged at regular intervals, calculated to keep interest aroused. The lecturers could be obtained among broadminded and altruistic physicians or the faculty of the state university. The central organization, whether state or national could employ a part of its time and energy in no better way than in providing

a complete corps of efficient lecturers who could answer the call to some local organization.

There are many individuals who are looking for a field in which they can utilize their executive powers in a worthy way. There are many wealthy people who are ready and even anxious to donate funds to a worthy cause. We believe a no more worthy cause exists than the one just suggested.

Much work has already been accomplished by organization such as the Y. M. C. A. to encourage right living among young men, but little of it touches the group of busy individuals who are the victims as well as the causes of the Period of Retrogression.

C. H. Forsyth

Ann Arbor, Mich.

SPECIAL ARTICLES

A METHOD OF PLOTTING THE INFLECTIONS OF THE VOICE

Some time ago, while the writer was engaged in the study of the "tones" of certain oriental languages, it became desirable to represent visually the tonal movements or figures executed by the voice in actual speech. Records of native speech were taken by the Rousselot apparatus, and the wave-lengths in each tracing were measured throughout, resulting in a series of numbers for each utterance—which series we may for the moment suppose as included within the compass of two octaves, from 10 to 40 of our scheme.

In default of any record of previous attempts of this kind, the following scheme was first tried as the most obvious and simple. Beginning at the top, the unit lines of the coordinate paper were numbered in succession downward from 10 to 40. Then beginning at the left-hand margin the measured numbers from the record were plotted in order, each upon its numbered line, but each advanced beyond its predecessor by a constant interval chosen after experiment as best suited to bring out the features of the voice-inflection. A continuous line drawn through the series of plotted points would then represent the movement of voice as regards pitch. Finally the whole was brought into relation with concert pitch by measuring the wave-length of the record of a C-fork and marking its place among the numbered lines, and computing the positions of the other notes of the scale according to the well-known ratios of the diatonic scale.

The results seemed convincing; but a study of them revealed a certain distortion of vertical values similar in kind to the horizontal distortion of Mercator's maps. This was due to the fact that the number-intervals were equally spaced, whereas to our thought and visual imagination the semitone intervals are equal. The first step toward remedying the difficulty was obvious and easy. The letters of the twelve semitones took the places of the integers on the unit-lines of the chart. The next step—to find the new places of these integers—was not so easy. After some fumbling and groping the following points became clear.

1. Each semitone of the series brings with it to its new place the same numerical value which it had in its former position as a definite term of a geometrical progression of twenty-four terms between 10 and 40, with $\sqrt[12]{2}$ for the common ratio. In Table I. below are given these values for the upper octave. Those for the lower octave are simply twice these. These numbers were entered on the chart against their respective semitones.

2. The integral numbers must next be assigned to their proper stations within this decimal series. Indeed 10, 20 and 40 already appear in that series, and so are assigned to position; while 15 and 30 are so close to semitone positions as to be practically coincident with them. A rough determination of the other positions might be made by the method of proportional parts, but the only real determination is by solving the equation of the geometrical progression just described. That equation is $y = a^x$, in which y and x are variables, and a is constant, namely the common ratio $\sqrt[12]{2}$. The values of y are the integral numbers from 10 to 40. By applying these values in succession to the equation, the corresponding values of x are obtained, that is the

vertical distance from line 10 to the level of each integer. These ordinates are given in Table II. below.

Another element of distortion, though very slight, was found in the assumption of equal spacing for the horizontal intervals between successive points in the plot. The spaces *ought* to vary somewhat according to the levels of pitch. It was, however, some time before it became clear that the single measurement determined the position of the point on *both* coordinates—on the vertical one as pitch, and on the horizontal one as time-elapsed between successive wave-crests in the record.

So amended, the scheme seems perfect. Nevertheless a suggestion or two may save much time and trouble to one who may have occasion to use it.

It is neither necessary nor desirable to measure separately every wave-length of the record. It is quite as well to measure them in groups of five together and take the average for plotting, if only one measure separately the very first wave and the last, so as to make sure of the pitch at those points. Similarly the intervals for the horizontal spacing need not be the very ones indicated by the measured numbers, but rather some constant fraction of them, such as will better bring out the features of the curve.

All the numbers concerned in the scheme are merely ratios setting forth the relationships between the various elements of it within the compass of two octaves of pitch, which is quite sufficient to cover the range of any voice in ordinary speech. The scheme may therefore be used just as it stands if the measurements do not exceed its limits. If they do, the whole system may be raised an octave by the simple device of dividing the integral numbers throughout by 2, or lowered an octave by multiplying them by 2. Or it may be raised a fourth by multiplying them by 0.7, or lowered a fourth by multiplying them by 1.5—taking pains however in these last cases to shift the semitone letters correspondingly.

Since the semitone intervals are all equal, the C which represents concert pitch may be placed anywhere in the field where its measured wave-length indicates. All the other semitone letters then will take their places at the same constant distances as in the scheme described.

TABLE I

Ratios of the Tempered Scale

C	10
B	10.60
A♯	11.23
A	11.89
G♯	12.60
G	13.35
F♯	14.14
F	14.98
E	15.87
D♯	16.81
D	17.81
C♯	18.87
C	20

TABLE II

Ordinates of the Number Series

Number	Distance	Number	Distance
10	000	26	16.54
11	165	27	17.19
12	316	28	17.82
13	454	29	18.43
14	582	30	19.02
15	702	31	19.58
16	814	32	20.14
17	918	33	20.67
18	1,017	34	21.19
19	1,111	35	21.69
20	1,200	36	22.17
21	1,284	37	22.65
22	1,365	38	23.11
23	1,442	39	23.56
24	1,515	40	24.00
25	1,586		

CORNELIUS BEACH BRADLEY
UNIVERSITY OF CALIFORNIA

SOCIETIES AND ACADEMIES

THE BIOLOGICAL SOCIETY OF WASHINGTON

THE 557th regular meeting of the society was held in the Assembly Hall of the Cosmos Club, Saturday, May 20, 1916, called to order by President Hay at 8 P.M., with 30 persons present.

On recommendation of the council, James L. Peters was elected to active membership.

The president announced that the council of the society had voted to adopt the custom of medical societies and of many other scientific societies limiting the members to speak but once during the

discussion of papers and of asking the original speaker to answer all questions at the end of the discussion and to close the same.

Under the heading of brief notes and exhibition of specimens, Dr. Howard E. Ames referred again to the dorsally placed mammæ of the coypu (*Myocastor coypu*) and exhibited photographs of a female coypu in the collection of the Philadelphia Zoological Society showing the mammæ so placed.

The first paper of the regular program was by A. T. Speare, "Some Fungi that Kill Insects." Mr. Speare spoke briefly of certain experiments that were conducted in Europe about 1885, in which place the "green muscardine" fungus was used in a practical way to combat the cockchafer of wheat. Reference was also made to similar work that has recently been conducted in Florida and Trinidad, B. W. I. The writer spoke also of the present status of the chinch-bug disease and of the brown-tailed moth disease. In regard to the latter he spoke in detail of the methods employed in spreading this disease in the field. At the end of the paper he exhibited lantern slides illustrating various types of entomogenous fungi, some of which were collected by him in the Hawaiian Islands. Mr. Speare's communication was discussed by General Wilcox and by Dr. Howard.

The second paper was by L. O. Howard: "The Possible Use of *Lachnosterna* Larvæ as a Food Supply." Dr. Howard briefly referred to the prejudice against insects as food, and gave an account of his experiments recently undertaken with white grubs sent in from Wisconsin. They were sterilized, thoroughly washed, the contents of the alimentary canal removed, and were then served as a salad and in a broth. They were eaten by several members of the Bureau of Entomology and by Mr. Vernon Bailey of the Bureau of the Biological Survey and were pronounced distinctly edible. The speaker urged further experimentation with abundant species of insects as to their food value. Dr. Howard's communication was discussed by the chair, Mr. W. E. Safford, General Wilcox and Medical Inspector Ames.

The last paper was by W. E. Safford: "Agriculture in Pre-Columbian America." Mr. Safford described the various plants used by the early inhabitants of America, particularly those of Mexico, Central and South America, the manner of their use and preparation, and called attention to those employed at the present day and which have been adopted by civilized man. The prominent part which these plants played in the life of the pre-Columbian inhabitants is shown in ceremonial objects, earthenware products, etc., ornamented by designs based on these plants and in some cases by molds of parts of plants. Mr. Safford's communication was illustrated by numerous lantern-slide views of the plants under consideration and of many objects bearing plant designs. It was discussed by the chair, General Wilcox and Professor E. O. Wooton.

M. W. Lyon, Jr.,
Recording Secretary

ANTHROPOLOGICAL SOCIETY OF WASHINGTON

At the 499th regular and 37th annual meeting of the Anthropological Society of Washington, on April 18, Dr. John R. Swanton, president of the society, read a paper on "The Influence of Inheritance on Human Culture."

The speaker distinguished between the physical and mental traits which one inherits in his own person, and the store of ideas and things which have been passed down to him by previous generations. The environment into which one is born is of two kinds, the environment unaffected by man, and the environment as modified by man; and the advancement of a tribe depends on the amount of environment it is able to grasp and transmit. In this way a mental and material capital is laid up which enables further progress to be taken much more easily. Nevertheless, all of this world capital is not good, since false ideas and injurious institutions may be transmitted as well as true principles and beneficent institutions. One of the most pernicious of these institutions is that which permits monopolization of ideas and things by limited classes. A general diffusion of knowledge and improvement of the means of distributing it has largely destroyed monopoly in ideas, but monopoly in property still persists. The cure for this condition is to be found, the speaker believed, either in binding together use and ownership in such a manner that they can not be separated, or in vesting ownership in an immortal body such as the state and allowing use to individuals during their lives.

The following officers were elected for the ensuing year: President, Dr. John R. Swanton (reelected); Vice-president, Mr. William H. Babcock; Secretary, Miss Frances Densmore; Treasurer, Mr. J. N. B. Hewitt (reelected); Councillors, Dr. Truman Michelson, Mr. Neil M. Judd, Mr. Francis La Flesche, Dr. C. L. G. Anderson, and Dr. Edwin L. Morgan.

Frances Densmore,
Secretary

SCIENCE

FRIDAY, JULY 14, 1916

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

IDEALS OF CHEMICAL INVESTIGATION[1]

LESS than three centuries ago an outspoken student of nature sometimes faced the grim alternatives of excommunication, imprisonment, or death. To-day he no longer needs to conceal his thoughts in cryptic speech or mystic symbolism. Although the shadow of incomprehensibility may still darken the language of science, mystery is no longer necessary to protect the scientific investigator from persecution. The generally recognized value of the truth with his domain gives him the right to exist.

The courage needful for the task of addressing this august assembly on a topic concerning chemistry is, therefore, of a different order from the courage required for such a task in the days of Galileo. The problem to-day is not how to obscure the thought, but rather how to elucidate its inevitable complications.

Modern chemistry has had a manifold origin and tends toward a many-sided destiny. Into the fabric of this science men have woven the thought of ancient Greek philosophers, the magic of Arabian alchemists, the practical discoveries of artisans and ingenious chemical experimenters, the doctrine of physicists, the stern and uncompromising logic of mathematicians, and the vision of metaphysical dreamers seeking to grasp truths far beyond the reach of mortal sense. The complex fabric enfolds the earth—indeed, the universe—with its far-reaching threads.

[1] Oration delivered before the Harvard Chapter of the Phi Beta Kappa in Sanders Theater, Cambridge, Mass., on June 19, 1916.

The history of the complicated evolution of chemistry is profoundly significant to the student of human thought. Long ago, at the very dawn of civilization, Hindu and Greek philosophers were deeply interested in the problems presented by the nature of the universe. They speculated intelligently, although often with childlike naiveté, concerning energy and the structure of matter; but they forbore to test their speculations by experiment. They builded better than they knew; their ancient atomic hypothesis, ardently supported but very inadequately applied two thousand years ago, now finds itself installed in the innermost recesses of chemical theory. Independently, ancient artisans and medieval alchemists, dealing with the mysterious actual behavior of things, acquired valuable acquaintance with simple chemical processes. After much chemical knowledge of facts had been gained, alchemy sought the aid of philosophy. Thus, little by little, order was brought into the chaos of scattered experience. But strictly chemical knowledge alone was inadequate to solve the cosmic riddle; it had to be supplemented by knowledge of heat and electricity—agencies which produce profound alterations in the chemical nature of substances. Thus the study of physics was combined with that of chemistry. Again, since mathematical generalization is essential to the study of physics, this discipline also was, of necessity, added to the others. All these powerful tools taken together having failed to penetrate to the ultimate essence of things, imagination is invoked, and physiochemical dreams to-day conceive a mechanism of infinitesimal entities far beyond our most searching powers of direct observation.

Chemistry has not grown spontaneously to its present estate; it is a product of human mentality. The science which we know to-day is but an echo of the eternal and incomprehensible "music of the spheres," as heard and recorded by the minds of individual men. Impersonal and objective although matter and energy may be, their appreciation by man involves much that is subjective. The history of science, like all the rest of human history, is, as Emerson said, "the biography of a few stout and earnest persons."

Robert Boyle, self-styled "the skeptical chymist," a gentle spirit skeptical only of the false and vain, pure-minded aristocrat in an age of corruption; Mikhail Lomonosoff, poet, philosopher, philologist and scientific seer, far outstripping contemporary understanding; Antoine Lavoisier, whose clear mind first taught man to comprehend, after thousands of years, the mighty stolen gift of Prometheus; John Dalton, Quaker peasant, who found convincing chemical evidence for the ancient atomic hypothesis; Michael Faraday, a blacksmith's son, whose peerless insight and extraordinary genius in experiment yielded theoretical and practical fruits beyond the world's most daring dreams—these men and a few score others are the basis of the history of chemistry. The science has not come into being, Minerva-like, full-grown from the brain of Jove; she has been born of human travail, nursed and nourished from feeble infancy by human caretakers, and she sees the universe to-day through human eyes.

The diversified origin of chemistry has shaped the varied contemporary application of the science and its many-sided destiny in the years to come. Chemistry has wide theoretical bearings, but at the same time is concerned with the crudest and most obvious affairs of manufacture and every day life. Chemical knowledge must form an essential part of any intelligent philosophy of the nature of the universe, and alone can satisfy one manifestation of that intense intellectual curiosity which to-day, no less

than of old, yearns to understand more of the fundamental nature of things. On the other hand, rational applied science to-day must follow in the footsteps of the swiftly advancing strides of theory. The laws of chemistry can not be adequately applied until they have been discovered. Chemical insight, concerned with the intimate changes of the substances which are all about us as well as within our bodies, furnishes us with the only means for employing material things to the best advantage. Chemical processes appertain in large degree to medicine, hygiene, agriculture and manufacture; these processes depend upon laws of which the perfect understanding is essential to the full development of most of the activities of civilized life.

However oblivious we may be of the inexorable laws of chemistry, we are ever under their sway. Our consciousness is housed in a mortal shell, consisting primarily of compounds of less than a score of chemical elements. The physiological behavior of our bodies is inevitably associated with the chemical changes or reactions among highly intricate chemical unions of these few elements. The driving tendency or immediate cause of the reactions which support life is to be found in the chemical affinities and respective concentrations of the several substances. Our bodies are chemical machines, from which we can not escape except by quitting our earthly life. The nature of the chemical elements and their compounds therefore presents one of the most interesting and important of all problems offered to mankind. That the study of chemical problems of life is consistent with the study of man in a biological, a psychological, or a spiritual sense is obvious. To-day the epigram, "The proper study of mankind is man," must be greatly broadened in order to correspond with modern knowledge.

These words regarding the origin and significance of chemistry serve as an introduction. Your committee has honored me by the request that I should tell you something about the object and outcome of my own endeavors, and these could be made clear only by reviewing the peculiar nature of chemistry. In my case the incentive to the pursuit of science was primarily that intense curiosity concerning the nature of things which echoes down the ages from the time of the ancient philosophers. To the feeling of curiosity, as time went on, was added the perception that only through a knowledge of the fundamental laws of chemistry can men use the resources of the world to the best advantage. Any further gain in this knowledge must, sooner or later, directly or indirectly, give mankind more power. Even an abstract chemical generalization must ultimately be of priceless service to humanity, because of the extraordinarily intimate relation between theory and practise.

The field is wide, and it is traversed by many paths. Among these one must be chosen and persistently followed if progress is to be made; and in my case that one was the study of the fundamental attributes or properties of the chemical elements, and the relation of these properties to one another. The work was undertaken with the hope of helping a little to lay a solid foundation for our understanding of the human environment.

What, now, are the fundamental attributes of the elements? First and foremost among these stands *weight*—the manifestation of the all-pervading and mysterious force of gravitation possessed by all forms of matter. Hand in hand with this attribute of weight goes the equally inscrutable property of inertia—that tendency which causes a body once in motion to keep on moving forever in the same straight line, if

not acted upon by some new force. The idea of inertia, conceived by Galileo and amplified by Newton, was one of the starting points of both modern philosophy and modern physics. So far as we know, weight and inertia run parallel to each other. Of any two adjacent bodies, that having greater weight has also greater inertia. Hence they may be determined at one and the same time, and this Siamese-twinlike conjunction of properties establishes itself at once as perhaps the most fundamental of all the attributes of matter. Next perhaps comes volume, the attribute which enables matter to occupy space, with the corollaries dealing with the changes of volume caused by changes of temperature and pressure. Other fundamental properties are the tendency to cohere (which has to do with the freezing and boiling points of the liquids) and the mutual tendency of the elements to combine, almost infinite in its diversity, which may be measured by the energy-changes manifesting themselves during the reaction of one substance with another.

These are only a few of the important properties of the elements, but they present an endless prospect of further investigation, in spite of all that has been done during the past hundred years. For as yet we know only the surface of these things, and comprehend but little as to the underlying connections between them and the reasons for their several magnitudes. Why, for example, should oxygen be a gas, having an atomic weight just four times as great as that of helium, and why should it have an intense affinity for sodium and no affinity whatever for argon or fluorine? No man can answer these questions; he can discover the facts, but can not yet account for them. The reasons are as obscure and elusive as the mechanism of gravitation. But we shall not really understand the material basis upon which our life is built until we have found answers to questions of this sort.

In order to correlate the properties of the elements, and to attain any comprehension of their significance, one must first exactly ascertain the facts. Therefore, my endeavor has been to institute systematic series of experiments to fill the gaps in our knowledge of the actual phenomena. In much of this work I have had the invaluable aid of efficient collaborators, for which I am grateful.

The atomic weights were the first of the fundamental properties of the elements to receive attention in carrying out this plan. These, as every one who has studied elementary chemistry knows, represent the relative weights in which substances combine with one another. They are called atomic weights rather than merely combining proportions because they can be explained satisfactorily only by the assumption of definite particles which remain indivisible during chemical change. Even if some of these particles or so-called "atoms" suffer disintegration in the mysterious processes of radioactive transformation, the atomic theory remains the best interpretation of the weight-relations of all ordinary chemical reaction. Indeed, it is entrenched to-day as never before in man's history.

The determination of atomic weights is, primarily, a question of analytical chemistry—a question of weighing the amount of one substance combined with another in a definite compound—but its successful prosecution involves a much wider field. First, the substances must be prepared and weighed in the pure state, and next, they must be subjected to suitable reactions and again weighed with proof that in the process nothing has been lost and nothing accidentally garnered into the material to be placed on the scale pan. These requirements involve many of the principles of the

new physical chemistry, so that the accurate determination of atomic weights really belongs as much in that field as in the field of analytical chemistry.

At Harvard during the last thirty years the values of the atomic weights of thirty of the most frequently occurring among the eighty or more chemical elements have been redetermined. From data secured here and elsewhere is compiled an international table of atomic weights, revised from year to year by an authoritative committee composed of representatives of various nations. The values thus recorded are in daily use in every chemical laboratory throughout the world, serving as the basis for the computation of countless analyses performed by the analytical chemist, whether for technical or for scientific purposes.

This practical utility of atomic weights, although not forgotten, was not the prime incentive in the work under discussion. The real inspiration leading to the protracted labor of revising these fundamental quantities was the hope of finding some clue as to the reasons for their several magnitudes, and for the manifest but incomprehensible relationships of the elements to one another.

The unsolved cosmic riddle of the meaning of the atomic weights may have far-reaching significance in another direction, because the atomic weights may be supposed to hold one of the keys to the discovery of the mechanism of gravitation. The mutual attraction of the earth and sun, for example, must be due to the countless myriads of atoms which compose them, each atom possessing, because of its own appointed relative atomic weight, a definite if infinitesimal gravitational force attracting other atoms. If we could discover the reasons for the individual atomic weights, we should probably gain a far better understanding of the all-embracing force built up of the infinitesimal effects represented by their individual magnitudes.

Among the striking facts to be considered is the constancy of gravity (and, therefore, of the sum total of the weights of all the atoms concerned) as shown in many ways. Moreover, not only is the sum total of the weights of the atoms remarkably constant, but also in many cases the values for the individual elements are found to be numbers of amazing constancy. Silver from all parts of the world and from many different ores yields always the same value; copper from Europe has the same atomic weight as the native metal mined under the bottom of Lake Superior; and yet more wonderful, the iron which falls from the sky, in meteorites having their birth far beyond the terrestrial orbit, has precisely the same atomic weight as that smelted in Norway. Many atomic weights, therefore, must be supposed to be constant, whatever the source of the elements.

Although thus we know only one kind of copper and iron and silver, evidence has recently been discovered which points towards the existence of at least two kinds of metallic lead. Every sample of *ordinary* lead always has exactly the same atomic weight as every other sample; but lead from radioactive minerals—lead which seems to have come from the decomposition of radium—has neither the same atomic weight nor the same density as ordinary lead, although in many of its properties, including its spectrum, it seems to be identical. This recent conclusion, reached only two years ago at Harvard, has been confirmed in other laboratories, and it now seems to be beyond question. Whatever may be the ultimate interpretation of the anomaly, the solution of this cosmic conundrum must surely give us a new idea of the essential nature of matter. Indeed, the fascinating subject of radioactivity bids

fair to give us in many ways an entirely new insight into the innermost structure of the atom.

During the progress of the study of the combining proportions of the elements, it became more and more evident to me that the atomic weights should be considered not only in relation to one another, but also in relation to many other essential distinguishing properties of the elements. This wider problem involved a great extension of the experimental field.

Among other attributes of the various forms of matter, compressibilities, surface tensions, densities, dielectric constants, heats of reaction and electromotive forces have begun to receive attention, and already many new data have been accumulated. The explanation of the nature of these researches would take us far beyond the scope of this present address, but their object deserves attention. This object is the correlation of the various properties into a consistent whole, in the hope of tracing the unknown physical influences which determine the nature of the elements.

The rigorous science of thermodynamics enables us to predict in logical and precise fashion some of the relations between physical properties. My hope is not only to aid in providing accurate experimental basis for calculations of this kind, but also to achieve the correlation of different properties, apparently independent of one another from a thermodynamic point of view, thus, perhaps, enabling one by inductive reasoning to penetrate further into the causes which lie back of all the attributes of matter.

In attempting to follow this inductive path comparisons of the properties of the elements have been made in two different ways.

On the one hand a given property of one element has been compared with the same property of another. For example, the question, "Which of the two elements, cobalt or nickel, has the heavier atom?" was answered by parallel determinations, using the same methods, conducted side by side in the laboratory. Cobalt was found to possess the higher atomic weight.

On the other hand, the attempt has been made to discover a relation between the different, apparently quite distinct, properties of a single element. For example, one may ask: "Have the low melting and boiling points of phosphorus any connection with its small density and its large compressibility?" Here one compares various properties of the same element, and one seeks to discover if all are based upon some common, ultimate characteristic of phosphorus, of which the properties are merely symptoms.

The inductive methods used in comparisons of this sort can not be explained here to-day. They are partly statistical, partly mathematical and partly graphical. From the nature of the problem, which involves many unknown variables, perfect mathematical exactness is not to be expected. Nevertheless, little by little, one may hope to trace the conflicting tendencies, and ascribe them to a few common causes.

With the help of these methods the tentative conclusion has been reached that the space occupied by the atom and molecule in solids and liquids is highly significant. The actual atomic bulk or volume is diminished but slightly by moderate mechanical pressures, and by cooling even to the absolute zero; but it is very greatly affected, apparently, by the mutual attractions of the atoms, called cohesion and chemical affinity. Usually the less volatile a substance (that is to say, the more firmly it is held together by cohesion) the greater is its density and the less is its compressibility, other things being equal. Greater cohesion is associated

with greater compactness. Likewise the existence of powerful chemical affinity between elements forming a compound is usually associated with great decrease in volume during the act of combination, and consequent increase in the density of the product in relation to the average density of the constituents. Thus we can hardly escape the inference that both cohesion and affinity, by pulling the atoms together with enormous pressure, actually exert a compressing effect upon the atoms, or at least upon the space which they demand for their occupation. The result of each of these compressing agencies is found to be greater the greater the compressibility of the substances concerned—a new evidence of the reasonableness of the inference. Not always are these effects easily traced, because the situation is often complicated, and the several effects are superposed. Nevertheless, enough evidence has been obtained to leave but little doubt, at least in my mind, as to the manner of working of the essential agencies concerned.

But we need not dwell upon this tentative hypothesis. Many more data and much more thought are necessary to establish it in an impregnable position, although no important inconsistency has thus far been pointed out in it. At present it may be looked upon as valuable because it, like other hypotheses of this type, has stimulated thought and experiment concerning the fundamental facts with which it deals.

As the years go on, the recent contributions to the study of atomic weights and volumes and other properties will be sifted and tested; and such contributions as may stand the test of time will take their places among the multifarious array of accepted chemical facts, laws and interpretations accumulated by many workers all over the world.

But we may well ask: What use, in the years to come, will mankind make of this knowledge gained step by step through the eager study of many investigators?

Chemistry has, indeed, a many-sided destiny. A mere catalogue of the countless applications of the science, which underlies many other sciences and arts, would demand time far exceeding the limits of this brief discourse. Some of the more obvious uses of chemistry have become daily topics in the public press. America is gradually awakening to the consciousness that, because every material object is composed of chemical elements and possesses its properties by virtue of the nature of these elements, chemistry enters more or less into everything. We perceive that chemical manufactures must be fostered, and also that chemical knowledge must be applied in many other industries not primarily of a chemical nature. Although chemistry plays so prominent and ghastly a rôle in war, her greatest and most significant contributions are towards the arts of peace. Even explosives may be highly beneficent; they may open tunnels and destroy reefs, furthering friendly communication between men; dig ditches for irrigation; help the farmer in his planting; and in many other ways advance the constructive activities of mankind. Again, poisonous gases, confined and harnessed within safe limits, may render valuable aid to humanity in preparing precious substances otherwise unattainable.

Such obvious and well recognized offices of chemistry need no further presentation to this intelligent company. Neither is it necessary for me to call your attention to the services which science may render to agriculture through the chemical study and enrichment of the soil in preparing it for the development of those subtle chemical mechanisms called plants, upon which we depend for our very existence.

There is a further beneficent possibility

worthy of more than passing mention—namely, that which arises from the relation of modern chemistry to hygiene and medicine. Already your attention has been called to the indisputable fact that the human body is, physiologically considered, a chemical machine. For this reason, future knowledge of chemical structure and of organic reaction may perhaps revolutionize medicine as completely as it was revolutionized by the devoted labors of Pasteur—not by doing away with his priceless acquisitions of knowledge, but rather by amplifying them. Chemistry may show how germs of disease do their deadly work through the production of subtle organic poisons, and how these poisons may be combated by antitoxins; for both poisons and antitoxins are complex chemical substances of a nature not beyond the possible reach of chemical methods already known. In that far-off but not inconceivable day when the human body may be understood from a chemical standpoint, we shall no longer be unable to solve the inscrutable problems which to-day puzzle even the most learned hygienist and physician. Is not a part, at least, of the tragedy of disease a relic of barbarism? A race which could have put as much energy and ingenuity into the study of physiological chemistry as mankind has put into aggressive warfare might have long ago banished many diseases by discovering the chemical abnormalities which cause them.

May not the study of subtler questions, such as the nature of heredity, also lead us finally into the field of chemistry in our search for the ultimate answer? Even psychology may some time need chemical assistance, since the process of thinking and the transmission of nervous impulse are both inextricably associated with chemical changes in nervous tissue; and even memory may be due to some subtle chemical effect. In the realm of thought there can be no question of the blessed service already performed by science in dispelling grim superstitions which haunted older generations with deadly fear.

In brief, more power is given mankind through the discoveries of chemistry. This power has many beneficent possibilities, but it may be used for ill as well as for good. Science has recently been blamed by superficial critics, but she is not at fault if her great potentialities are distorted to serve malignant ends. Is not this calamity due rather to the fact that the spiritual enlightenment of humanity has not kept pace with the progress of science? The study of nature can lead an upright and humane civilization ever higher and higher to greater health and comfort and a sounder philosophy, but that same study can teach the ruthless and selfish how to destroy more efficiently than to create. The false attitude toward war, fostered by tradition and by the glamor of ancient strife, is doubtless one of the influences which have held back mankind from a wider application of the Golden Rule.

There is, in truth, no conflict between the ideals of science and other high ideals of human life. With deep insight, a poetic thinker on life's problems, in the opening lines of a sonnet, has said:

Fear not to go where fearless Science leads,
Who holds the keys of God. What reigning light
Thine eyes discern in that surrounding night
Whence we have come, . . .
Thy soul will never find that Wrong is Right.

Our limited minds are confined in a limited world, with immeasurable space on all sides of us. Our brief days are as nothing compared with the inconceivable æons of the past, and the prospect of illimitable ages to come. Both infinity and eternity are beyond our mental grasp. We know that we can not hope to understand all the

wonders of the universe; but, nevertheless, we may be full of hope for the future. Step by step we gain in knowledge, and with each step we acquire better opportunity for improving the lot of mankind, and for illuminating the dark places in our philosophy of nature. Although we shall none of us live to see the full development of the help which science may render to the world, we rejoice in the belief that chemistry has boundless service still in reserve for the good of the human race.

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THE ONE HUNDREDTH ANNIVERSARY OF THE U. S. COAST AND GEODETIC SURVEY[1]

THE honor of being one of the speakers on this memorable occasion is highly appreciated, in spite of a perfect realization of the fact that it comes to me solely because I have had the fortune, good or bad, to survive my predecessors. To live long, according to a well-known proverb, is to prove that one is not a favorite of the gods; on the other hand, to live long is to furnish fairly good evidence that one has not been found guilty of a capital crime.

During the past two days the various activities of this service have been so thoroughly discussed by competent critics that there is little room for further comment. As I am, in a way, representing the men who directed these activities during the century of its existence, I choose to speak, not for them, but of them, the superintendents of the Coast and Geodetic Survey, with some reference to their share in the development of the work.

To the republic of Switzerland American science is enormously indebted. Thence came Agassiz, Guyot, Lesquereux, and others who stirred us into scientific activity fifty years ago, and more than a half century earlier came Ferdinand Hassler, organizer and first superintendent of the Coast Survey. No brief sketch can do justice to Hassler's personality or to his all-powerful influence in molding the character of the new organization, the first of the so-called "scientific bureaus" of the United States government. Educated in the best schools of Europe, intimately acquainted with the most eminent scientific men of the Old World and with experience in the trigonometrical survey of his native country, he possessed exactly the qualifications necessary to a successful launching of the new enterprise. Not the least of these qualifications was one rather rare among men of science, though common enough in the so-called "learned professions." With intellectual power and technical skill of the highest order he combined an equally high appreciation of his own merits. It is related that when invited to organize and direct the survey of the coasts, which had been strongly recommended to Congress by Thomas Jefferson, he demanded and received a salary equal to that of the head of the department to which the new bureau was assigned. *Tempora mutantur!* There is also a tradition that when the President objected, saying, "Your salary is as large as that of my Secretary of the Treasury, your superior officer," he replied: "Any president can make a Secretary of the Treasury but only God Almighty can make a Hassler."

Visiting Europe to purchase the necessary instruments and standards of measure, he was detained in England as an alien enemy until 1815 and thus a period of nearly ten years elapsed between its authorization by act of Congress and the actual inception of the Survey.

Hassler's plan of organization, broad and thoroughly worked out, is still the funda-

[1] Address given at the banquet, April 6, 1916.

mental directing ordinance of the Coast Survey. He provided for the division of its operations into three great groups, the geodetic, the topographic and the hydrographic, and of these he considered the geodetic the most important as affecting the accuracy and final value of the results. In insisting upon a degree of precision in the execution of these operations hitherto undreamed of in this part of the world, he "set the pace" which the Survey has since maintained with such distinction and which it must continue to maintain if its future is to be worthy of its past.

Naturally a man of his temperament was likely to come into occasional conflict with government authorities who were quite unable to appreciate the nature and demands of such a service. The very refinement in measure and computation which was the chief merit of the work came near being the undoing of Hassler as it has, indeed, of more than one of his successors. In 1842 a congressional committee made a searching and unfriendly investigation of the Survey, during which, as one of its members confessed on the floor of the House, it was found that of the subject under consideration the superintendent knew so much and the inquisitors so little that the committee was helpless in his hands. Although the work of this committee, like that of most of its successors, was an inquisition rather than an investigation, its report was practically a complete endorsement of the principles on which the Survey had been conducted by Hassler. His death occurred in the following year, but not before a complete and comprehensive plan for the continuation and expansion of the work had been outlined and approved by Congress.

The duty of executing this plan, of building upon the foundation laid by Hassler, fell to one who was everywhere acclaimed as the best fitted for the task.

Alexander Dallas Bache had inherited through his grandmother, the famous "Sally Bache" of the Revolutionary period, only daughter of Benjamin Franklin, not only his distinguished ancestor's tastes for scientific pursuits, but also much of his tact and skill as a diplomat, a quality that contributed in no small degree to his notable success as superintendent. After graduating from West Point Military Academy at the age of eighteen years, at the head of his class, with the extremely rare record of having completed the entire course without having received a single demerit, he had enjoyed a wide experience in public service in various capacities, besides being actively engaged in important researches in magnetism and electricity.

At the age of thirty-seven years he had already won distinction as a scientific man of originality and power and his appointment as Hassler's successor was recommended by all of the principal scientific societies and institutions of learning in the country. His service extended over a period of almost exactly a quarter of a century, being terminated by his death in 1867. The splendid superstructure which Bache erected upon Hassler's foundation has received the highest praise from competent judges in all parts of the world.

During his administration he was successful in securing the confidence of Congress and the operations of the Survey were greatly extended. While keeping well in mind the practical results, for the attainment of which the organization was created, he had a keen eye for the purely scientific by-products of which he gathered a great harvest. The distinguished mathematician and astronomer, Professor Benjamin Peirce, on assuming office as his successor, said of the Coast Survey at the end of its first half century: "What it is Bache has made it. It will never cease to be the admiration of the scientific world. It is only necessary conscientiously and faith-

fully to follow in his footsteps, imitate his example and develop his plans."

During the later years of Bache's administration Professor Peirce had directed the longitude operations of the Survey, acting also as a sort of general scientific adviser and naturally his policy after becoming superintendent was essentially that of his predecessor. Many of the larger operations of the Coast Survey had been suspended during the Civil War, in which both the superintendent and his assistants had played an important part. The execution of the primary triangulation on both the east and west coasts was resumed by Peirce and an exploration and survey of the newly acquired territory of Alaska was begun. The most important act of his administration was the development of a plan for two gigantic chains of triangles extending across the continent, thus covering the whole country by a trigonometrical survey and joining the systems of the Atlantic and Pacific coasts. This scheme received the approval of Congress and was in many respects the most remarkable work of its kind ever undertaken by any government.

Peirce had continued to hold his professorship in Harvard University and also his many other activities, as a writer of text-books, a frequent contributor to scientific journals, etc., and at the age of sixty-five years, doubtless finding his burden too heavy, resigned the superintendence of the Survey in 1874, after a service of seven years, but he continued to act for a time as "consulting geometer." As a genius in mathematics and astronomy he is easily the star of first magnitude in the Coast Survey galaxy.

Peirce's successor was Carlile Pollock Patterson, naval officer and son of a naval officer.

Previous to his appointment as superintendent he had served for more than a dozen years as hydrographic inspector, an appointment usually held by a naval officer, active or retired.

The general plans of the Survey as perfected by his predecessors were adhered to by Patterson, whose term as superintendent covered a period of seven years, ending with his death in 1881.

His successor, Julius Erasmus Hilgard, was brought at the age of ten years from his birthplace in Germany by his father, a highly educated and successful lawyer and jurist in his own country, who settled on a farm in Illinois near the city of St. Louis. Educated by his father, young Hilgard at the age of eighteen years went to Philadelphia to study to be a civil engineer. There he soon attracted the attention of Professor Bache, who invited him to become one of his assistants in the Coast Survey. In 1845 he joined the corps, his connection with it terminating on his resignation in 1885 after forty years of service. His industry and rare talents brought rapid promotion and in 1862 he became assistant in charge of the office in Washington, a position next in importance and responsibility to that of superintendent. In this capacity he served for nineteen years until his appointment as superintendent in 1881. In the meantime his reputation had become international. He was one of the most influential members of the International Metric Commission that met in Paris in 1872; was made a member of its permanent committee and on the organization of the International Bureau of Weights and Measures, with headquarters at Paris, he was offered the directorship. This honor he declined. By training, ability and experience Hilgard was more completely fitted for the headship of the Coast Survey than any other person who has ever served in that capacity and it was unquestionably the goal which he had hoped to reach.

Recommended for the appointment as Bache had been forty years earlier, by

scientific men, learned societies, colleges and universities, he began his administration under the most favorable conditions. During the earlier years his work justified the confidence reposed in him, but in the meantime, unknown to his friends and perhaps unsuspected by himself, he had become the victim of an insidious disease which weakened the power of both his will and his intellect. Undoubtedly advantage was taken of this fact by others and an investigation of the affairs of the Survey brought to light certain irregularities in its business management that were at first believed to reflect upon the integrity of not only the superintendent, but of many of the older assistants, especially those employed in the field. The superintendent resigned in 1885 and a long and brilliant career thus ended in almost a tragedy.

The investigation referred to was made by a committee of three employees of the Treasury Department with Frank Manley Thorn, chief clerk of internal revenue, as chairman.

Mr. Thorn was placed temporarily in charge of the Survey, and afterwards by appointment of the President he continued to act as superintendent until the close of the first Cleveland administration. The unprejudiced historian can not fail to accord to Mr. Thorn great credit for the way in which he managed the affairs of the Survey during this trying period. Inspired by a prospect of participating in the spoils of office, a number of witnesses had volunteered testimony that was either grossly misleading or absolutely false, and this had been incorporated in the report of the commission of which he was chairman, along with a severe arraignment of the business methods of the Survey and of the integrity of several of its principal officers. During the nearly four years of his administration he learned much about the methods and requirements of such a service as the Coast Survey of which in the beginning he had been totally ignorant. A man of sterling integrity, he had the courage to revise this report by innumerable additions and annotations, practically vindicating the men against whom charges had been made, most of which were merely technical.

In spite of the unwholesome conditions existing in the beginning of Thorn's administration the operations of the Survey were continued without serious interruption and much important work was accomplished.

A much more regrettable state of affairs prevailed during a considerable period of the administration of General William Ward Duffield, who served as superintendent for about three years following his appointment in the autumn of 1894. Not only was the influence of the spoilsman again paramount, but for some unexplainable reason a number of men were dismissed from the force whose places could not be filled from any source whatever. Men of long and faithful service, whose reputation was international, were lost to the Survey at that time, though a few men afterwards were reappointed. It is charitable to assume that the superintendent, who was by profession a civil engineer with a record of good service in the Civil War, had passed the years of discretion before receiving his appointment. That the paralysis by which the service was then afflicted did not become complete was due entirely to an unwavering loyalty to its best traditions on the part of those who remained.

The historian would gladly pass over these unpleasant episodes, but a due regard for the good name and fame of many individuals involved demands brief reference to them.

I come now to the living, whose connection with the service is quite within the memory of most of those interested, and

of whose work little need be said. There are times when brevity is not only the soul of wit but also the essence of discretion.

Upon Henry Smith Pritchett, astronomer and son of an astronomer, fell the task of making a complete reorganization of the hydrographic operations of the Survey. From the earliest days these operations had been carried on almost entirely by naval officers detailed for that purpose, but during the war with Spain such details became impossible. The difficult problem thus presented was solved with marked success by Pritchett and this reorganization, though but one of many notable things accomplished during his comparatively short term from 1897 to 1900, must be regarded, I think, as the most important act of his administration.

The appointment of Otto Hilgard Tittmann, as successor to Pritchett on the resignation of the latter, was an event predetermined by his long connection with the service, which began in 1867, when he was seventeen years old, and continued without interruption for almost a half century, to his resignation in 1915. Inheriting through his mother the scientific tastes and special talents of the Hilgards, with successful experience in nearly every one of the various operations of the Survey, including many years as assistant in charge of the office and assistant superintendent, his remarkable career ended with the longest term as superintendent since the time of Hassler and Bache. Under his direction the Survey has advanced with great strides and so many important things have been accomplished that it is difficult to select even one for mention in this brief review, but among those of first rank will surely be found his personal and official services in representing the United States on numerous international commissions and boundary tribunals.

I am tempted to overstep the bounds laid down for me, to pay my tribute to the ability, faithfulness and loyalty with which the assistants of the superintendent have almost invariably supported him in the discharge of difficult and often disagreeable duties, and I use the term assistant as including not only those employed in the field, but also the office force; the computers, engravers, printers, mechanicians, clerks, etc., through whose hands all of the work of the field officers must pass before it becomes useful to the public. Without this support the ablest chief could accomplish little or nothing. I would like especially to speak of a few of the veterans of my own time who have passed away; of Whiting who, beginning with Hassler, had served for more than a half century and under every superintendent up to the day of his death; of Davidson, the oracle of the Pacific coast, whose service was nearly as long; of Schott, the severe but just judge at the head of the computing division; of Mosman, Fairfield, Eimbeck, Ogden, Grauger, Preston, Mitchell, Smith, Rodgers and others; it is a long roll but it is a roll of honor in the annals of the Survey. To them, and to many others, happily still living, I owe a debt of gratitude for their loyal cooperation and support.

I desire also to testify to the great importance to the service, of the cooperation of the army and navy, especially in the detail of officers from the army in the early days and from the navy during many years for special duty under the superintendent, to whom they were almost, without exception, unselfishly loyal.

I should like, also, to speak more than briefly of some of the famous men who were at various times attached to the Survey for longer or shorter periods, some of whom in this service laid the foundation of their future careers in which they achieved great distinction; of the great artists, Whistler and Alexander; the great scholars, Agassiz

(rather and son), Ferrel, the two Peirces, Gould the astronomer, and others; of Captain Derby, the "John Phœnix" of the world of wit and humor; of Blake, the inventor, and many others, but in this I may not indulge myself.

If I could summon their spirits from the "vasty deep" I am sure those of the former superintendents who are dead would join with those who are living in congratulating their successor who has recently been charged with the responsibility of directing its operations, on the thoroughly trained and competent corps of assistants who will aid him in carrying the Coast and Geodetic Survey into its second century. But perhaps even more important than these will be the traditions of a hundred years which he will not lightly put aside.

I confess to a feeling of *nausea* in these latter days whenever I hear the word *efficiency,* wrenched as it has been from its original meaning and made to stand for "the greatest possible output in the least possible time." The Survey has often been the object of adverse criticism, based on ignorance of the character of its work, because of the slowness of some of its operations. It is to its everlasting credit that as far as known no one has ever found fault with it for not keeping its work up to the highest standard attainable at the time.

Not "how much?" but "how well?" has been its criterion.

It is only by persistently adhering to standards of quality rather than quantity that it will continue to be as it was in the middle, and still is at the end, of its first century, "the admiration of the scientific world."

T. C. Mendenhall

Ravenna, Ohio

GRANTS FOR SCIENTIFIC RESEARCH

MEDICAL SCHOOLS AND LABORATORIES

(*Continued from Vol. XLIII., p. 681*)

The following list contains such facts as the committee has ascertained regarding the funds which are available for medical research in the United States and Canada.

Bender Hygienic Laboratory, Albany, N. Y. Dr. Ellis Kellert, Director. Income, not exceeding $200; available at discretion of Director.

Harvard University Medical School, Boston, Mass. Dr. E. H. Bradford, Dean. Funds approximately "between $350,000 and $375,000" exclusive of teaching fellowships, many of which are utilized for research.

Massachusetts Homeopathic Hospital, Boston, Mass. Dr. F. C. Richardson, Director. Evans Memorial Department of Clinical Research and Preventive Medicine. Income from fund of $260,000 available.

University of Chicago, Chicago, Ill.

Rush Medical College. Dr. J. M. Dodson, Dean. Appropriations from General Budget.

Otho S. A. Sprague Memorial Institute. Dr. H. Gideon Wells, Director. Approximately $35,000 per annum appropriated for research in medicine, used chiefly in paying salaries of research workers.

Memorial Institute for Infectious Diseases, Chicago, Ill. Dr. Ludvig Hektoen, Director. Income from $2,000,000 devoted to research in infectious diseases.

Northwestern University, Chicago, Ill. Dr. C. W. Patterson, Dean.

James A. Patten Fund for Medical Research. $200,000. Income approximately $10,000. Available in all departments of medical research but used mainly in department of bacteriology and in research on tuberculosis.

James A. Patten Fund for scholarships in medical research. $50,000. Income approximately $2,500. Available under same conditions as above.

Vail Research Fund. $2,000. Income available for a research fellowship.

Western Reserve University, Cleveland, Ohio. Dr. C. A. Hamann, Dean.

Cushing Fund. $170,000. (Cushing Laboratory of Experimental Medicine.) Apparatus Fund $17,000. Payne, Crile Fund $8,000. Hanna Fellowship Fund $12,000.

McGill University, Montreal, Canada. Dr. Francis J. Shepherd, Dean. Douglas Research Fellowship in Pathology. $25,000.

Yale University, New Haven, Conn. Dr. George Blumer, Dean. Francis E. Loomis Fund. $20,000. Up to 1915 interest appropriated chiefly for departments of anatomy, physiology and pharmacology.

Tulane University, New Orleans, La. Dr. Isadore Dyer, Dean. Provision statedly for research in annual appropriations, not over $1,000 per annum.

Columbia University, New York, N. Y.

College of Physicians and Surgeons. Dr. S. W. Lambert, Dean. William T. Bull Memorial Fund. $32,100. Income available for research in surgery. Vanderbilt Clinic Endowment Fund. $115,000.

George Crocker Special Research Fund. Dr. F. C. Wood, Director. $1,441,150. Income available for cancer research.

Cornell University, New York, N. Y. Dr. W. M. Polk, Dean. Sage Foundation Fund for research in calorimetry in connection with ward patients. Occasional funds contributed for particular research work. There are four research fellowships in medicine.

Rockefeller Institute for Medical Research, New York, N. Y. Dr. Simon Flexner, Director. Endowment Fund 1912, $8,443,450.

University of Pennsylvania, Philadelphia, Pa. Dr. Wm. Pepper, Dean.

Robert Robinson Porter Fellowships in Research Medicine. $600 per annum. To be devoted to "investigation in medical sciences."

Robert M. Girvin Fellowship in Research Medicine. $650 per annum. Purpose similar to Porter Fellowship.

Henrietta Heckshер Fellowship in Medical Research. $500 per annum.

University of Pittsburgh, Pittsburgh, Pa. Dr. Thomas Shaw Arbuthnot, Dean. Mellon Fellowships. (1) $750 per annum. Open to graduates in medicine for research in the department of pathology. (2) $600 per annum for research in electrocardiography with clinical study of diseases of the heart.

Washington University, St. Louis, Mo. Dr. P. A. Schaffer, Dean. Provision for research made in departmental appropriations.

University of California, San Francisco, Calif. Dr. H. C. Moffet, Dean. Hooper Foundation. $50,000 annually for medical research. Approximately $1,000 appropriated annually from budget for research in anatomy, physiology and pathology. Department of medicine, $500 annually. Department of surgery, $800 annually. Department of pediatrics, $600 annually. Department of obstetrics and gynecology, $500 annually. Research position in department of pathology, $1,200 per annum.

Leland Stanford Jr. University, San Francisco, Calif. Dr. R. L. Wilbur, President. Coffin Research Fund for study of Tropical Diseases. Amounts for particular departments included in budget.

University of Toronto, Toronto, Canada. Robert Falconer, President. Medical Research Fund yields $15,000 per annum. Surgical Research Fund yields $1,000 per annum.

CHARLES R. CROSS,
Chairman

THE SECOND NATIONAL EXPOSITION OF CHEMICAL INDUSTRIES

THE Second National Exposition of Chemical Industries will be held at the Grand Central Palace, New York City, during the week of September 25–30, 1916. The Advisory Committee of the Exposition is as follows: Chas. H. Herty, *chairman*, Raymond F. Bacon, L. H. Baekeland, Henry B. Faber, Francis A. J. Fitzgerland, Bernard C. Hesse, A. D. Little, R. P. Perry, Wm. Cooper Procter, E. F. Roeber, George D. Rosengarten, T. B. Wagner, Utley Wedge, M. C. Whitaker and Charles F. Roth and Adriaan Nagelvoort, managers.

The roster of exhibitors includes most of the leading companies doing business with those industries wherein chemistry plays a part. From this list it appears that the exposition is already twice the size of its successful predecessor.

The managers anticipate an even greater number of visitors to attend this second exposition. The chemical and engineering societies that last year had their attention divided with the attractions of the exposition and the engineering congresses on the Pacific coast, have this year united and arranged to hold their annual meetings in New York during and in conjunction with the exposition.

The American Chemical Society will hold its annual meeting during the whole week—the program for the meeting is now being arranged and the committees appointed. The American Electrochemical Society has arranged to hold its meetings the latter part of the week, September 28, 29 and 30. The Technical Association of the American Pulp and Paper Industry is arranging its meeting for this week, and other societies are expected to hold meetings.

The Bureau of Commercial Economics at Washington is again cooperating with the exposition by arranging an elaborate program of motion pictures covering subjects dealing with the industries depending on chemistry. A few of the films that appear on the tentative program are: The match industry, the rubber industry, manufacture of explosives, varnish manufacture, silver mining, mining and manufacturing of iron, making of blotting paper, accident and fire prevention, manufacture and use of fertilizers and manufacture of steel.

SCIENTIFIC NOTES AND NEWS

THE dispensary building of the Orthopedic Hospital and Infirmary for Nervous Diseases, Philadelphia, has been formally dedicated to the memory of Dr. S. Weir Mitchell, one of the founders of the institution and for many years head of the hospital staff. At the entrance of the dispensary is a stone tablet on which is inscribed in bronze letters, "S. Weir Mitchell Memorial, Philadelphia Orthopedic Hospital and Infirmary for Nervous Diseases, 1915." A bronze tablet in the main waiting room states that the building is dedicated to the memory of Dr. Mitchell by his friends and patients. The address was delivered by the dean of American surgeons, Dr. William W. Keen, who was a close friend and associate of Dr. Mitchell for a period of more than fifty years.

ATTENTION is called in *Nature* to the fact that on June 24, the Rt. Hon. Henry John Moreton, Earl of Ducie, F.R.S., entered on his ninetieth year, having been born in 1827. He is the senior fellow of the Royal Society in point of election to that body, this dating from 1855. When Lord Moreton, he obtained from the Jurassic limestone of Burford the fossil species of star-fish named by Professor Edward Forbes *Solaster moretoni,* in honor of the finder. In connection it may be mentioned that Sir Robert Palgrave, F.R.S., entered on his ninetieth year in the early part of May, while Sir William Crookes attained the age of eighty-four on June 17.

WILLIAM MORTON WHEELER, professor of economic entomology and dean of the faculty of the Bussey Institution, of Harvard University, and Otto K. O. Folin, Hamilton Kuhn professor of biological chemistry in the Harvard Medical School, were given the doctorate of science at the University of Chicago convocation celebrating its twenty-fifth anniversary.

AT the quarter-centennial convocation of the University of Chicago, the honorary doctorate in science was conferred on John M. Clarke, state geologist of New York.

DR. WILLIAM H. HOLMES, chief of the Bureau of American Ethnology, and Dr. Aleš Hrdlička, of the U. S. National Museum, have been made corresponding associates of the Academia Nacional de Historia of Colombia.

AT a meeting of the Texas chapter of the Society of the Sigma Xi, on June 5, Dr. Frederic W. Simonds, professor of geology in the University of Texas, was elected president for the year. Dr. Simonds was one of the first five graduate students elected to membership in the Cornell chapter.

THE Yale Chapter of Sigma Xi has elected Professor R. S. Lull, president, and Professor W. R. Longley, vice-president, for the coming academic year.

DR. AXEL GAVELIN has been appointed director of the Swedish Geological Survey.

SIGNOR LEONARDO BIANCHI is a member of the new Italian ministry as a representative of the party he leads—that of the Constitutional Democrats. He is professor of psychiatry in the University of Naples and director of the university clinic for nervous and mental diseases, and it is understood that he will devote himself to hygienic and social problems arising out of the war.

PROFESSOR ALFRED STENZEL has been placed in charge of a clinic at the hospital of the University of Pennsylvania for the exclusive study of industrial and occupational diseases.

MR. FRANCIS HARPER has joined the staff of the Biological Survey of the U. S. Department of Agriculture.

DR. WILLARD J. FISHER, whose withdrawal from the department of physics at New Hampshire College was recently noted in SCIENCE, has been appointed honorary fellow in phys-

ics at Clark University for the academic year 1916–17.

The geologist and geographer T. A. Bendrat is about to start on an expedition to the headwaters of the Orinoco River in Venezuela to explore its sources and the surrounding region.

Dr. Julius Hayden Woodward, of New York, professor of diseases of the eye at the New York Post-graduate Medical School since 1908, and director of instruction in ophthalmology since 1913, died at his home on July 2, aged fifty-eight years.

The Kansas State Board is endeavoring to get the state universities to cooperate in an effort to induce the government to establish a health experiment and research laboratory in connection with each university school of medicine under the United States Public Health Service.

We learn from *Nature* that the formation by the British Advisory Council for Scientific and Industrial Research of a standing committee on mining, constituted so as to represent both the scientific and industrial sides, has now been completed. The standing committee includes the following members nominated by professional associations: Institution of Mining Engineers: Sir William Garforth, Dr. John Haldane, Dr. R. T. Moore, Mr. Wallace Thorneycroft; Institution of Mining and Metallurgy: Mr. Edward Hooper, Mr. Edgar Taylor; Iron and Steel Institute: Professor H. Louis; the South Wales Institute of Engineers: Mr. W. Gascoyne Dalziel; and the following members appointed directly by the advisory council: Sir Hugh Bell, Bart., Mr. Hugh Bramwell, Lieutenant-Colonel W. C. Blackett, Professor Cadman, Professor Frecheville, Mr. Bedford McNeill, Mr. Hugh F. Marriott, Sir Boverton Redwood, Bart., Mr. C. E. Rhodes. The advisory council has appointed Sir William Garforth to be chairman.

The California State Board of Health, in cooperation with the University of California, is conducting a state-wide malaria mosquito survey under the supervision of Professor W. B. Herms, consulting parasitologist for the state board and associate professor of parasitology in the University of California, who is assisted by Mr. S. B. Freeborn, instructor in entomology. The work began on May 10, and will continue through the summer. Probably three summers will be required to complete the survey of the entire state. The party travels by automobile, collecting mosquitoes, locating their breeding places, determining the presence or absence of malaria, distributing literature, lecturing and giving information on ways and means for the control of the insects. The Sacramento Valley and the northeastern portions of the state to the Oregon and Nevada state lines have already been covered. Thus far endemic malaria has been found at a maximum elevation of 5,500 feet and the Anopheline carriers have been located. Two or three new species of mosquitoes have been found.

The second Interstate Cereal Conference was held at the University of Minnesota, University Farm, St. Paul, on July 11, 12 and 13. At this conference there was a discussion of the various phases of cereal research relating to the region of which St. Paul may be considered the center. The program included papers on problems of wheat, oat, barley and flax production in the northwest; the grading of barley and corn; breeding winter wheats for Minnesota; ergot for rye; methods for the eradication of bunt or stinking smut; problems in flax diseases, and a symposium on milling and baking. Two days were devoted to the presentation and discussion of papers. The third day was used in an inspection of the plat work of the Minnesota Agricultural Experiment Station and of one of the local flour mills.

On August 24, 25 and 26, the third annual conference of the Society for Practical Astronomy will be held at the Bausch and Lomb Observatory in Rochester, N. Y. The president of the society, Mr. Latimer J. Wilson, urges all the members to attend these sessions and extends the invitation to any one interested in astronomy. Papers will be read showing the important work of the society and addresses on optical matters and their relation to astronomical research will be given. The Bausch and

Lomb Observatory is equipped with an 11-inch refractor constructed by the Bausch and Lomb Optical Company. The conference promises to be as successful as that of last year, which was held at the University of Chicago.

THE mathematicians of the Scandinavian countries, including Finland, will hold a reunion at Stockholm, from August 30 to September 2. The International Congress of Mathematicians was to have been held there at this time, but European conditions have rendered such a meeting impossible, and this reunion therefore serves as a partial substitute.

STUDENTS in the field course in geography at the University of Missouri, at Columbia, will take a waterways tour on the Mississippi River and Great Lakes during August. The tour, commencing at St. Louis, will include the following points: St. Paul, Minneapolis, Duluth, Houghton, Saulte Ste. Marie, Mackinac Island, Parry Sound, Toronto, Niagara Falls, Buffalo, Cleveland, Put-in-Bay, Detroit and Chicago. Work on the trip will consist of studies and lectures on the principal local industries, commerce on the Great Lakes, government improvements and aids to navigation, historic geography of the Lakes and Mississippi regions, and physiographic and geologic subjects. No previous study in geology is required of those desiring to make the trip. The course is open to both men and women whether enrolled in the university or not. Three to five hours' credit will be given to those who make the tour. Those not enrolled in the university will be given credit which will be accepted upon entrance by Missouri or other universities of equal standing.

IMPRESSED by the work of the Army Medical School and the inadequacy of the facilities provided for that work, Drs. John M. T. Finney and Joseph C. Bloodgood, of Baltimore, recently left with the president the following memorandum:

We are so impressed by the character and importance of the scientific work which is being done there we feel the need of bringing to the attention of yourself and the country the utterly inadequate facilities provided not only for purposes of investigation, but for those of instruction as well. The quarters are unsuited for existing conditions and they will prove still more so in case of any expansion of the service.

We furthermore, from our experience as teachers, believe that the Army Medical School should be in the vicinity of, and closely affiliated with, the newly established Walter Reed Hospital for the benefit of both institutions.

NORTH CAROLINA was the first state in the Union to recognize the need of geologic surveys within its borders. In 1823 an act of the general assembly authorized the board of agriculture to pay the expenses of "geological excursions" for a period of years, as a result of which several geologic reports on the state were published. South Carolina was quick to follow the example of her sister state and in 1824 established a State Geological Survey, whose geologic report, appearing in 1826, was the first issued under the patronage of any state. Massachusetts and Tennessee early established official Geological Surveys on a much larger scale than those of North and South Carolina, and in 1833 Maryland followed their example. To Maryland also belongs the credit of being the first state to undertake a topographic survey, in which she obtained the cooperation of the Coast and Geodetic Survey. This marks the beginning of the federal and state cooperation in such matters which is now so important in topographic mapping and in the investigation of our mineral resources. Bulletin 465 of the United States Geological Survey, entitled "The State Geological Surveys of the United States," includes a historical report of each state in which there is now a Geological Survey, giving also a sketch of early surveys and an account of the legal designation, organization, laws, appropriations, publications and nature of the work of each individual state. The bulletin is valuable as showing the early recognition of the need and value of basic investigations of our enormous latent mineral wealth.

THE University of Nevada has founded in both college and station a department of range management. Nevada contains immense areas too elevated for field agriculture, but perfectly adapted to the grazing of bands of cat-

tle and sheep. The range country in Nevada will never be broken up into farms; it can be used for nothing but range; it presents many unique and interesting problems. These center around the adaptation of grazing methods to the periods of growth and reproduction of the native forage plants with a view to making the fullest use of the range without further injury to the plant life. Mr. C. E. Fleming, Cornell, 1910, formerly of the Forest Service, Grazing Studies, has been chosen to head the new department which ranks as a full professorship in the university. Mr. Fleming has been in charge of the Federal Grazing Reserve at Jornada, New Mexico. Studies of the poisonous plants of the range will be carried on by Mr. Fleming and Dr. Jacobson, the head of the department of chemistry in the Nevada station. The project work of the Nevada Experiment Station is being based almost wholly on the problems of western agriculture; an effect is made, however, to maintain the high scientific character and accuracy of the work. The new department will have a set of problems characteristic of the peculiar agriculture of the western mountain country.

THE production of anthracite in 1915, as shown by the final figures compiled by C. E. Lesher, of the United States Geological Survey, from returns made by the operators, was 79,459,876 gross tons, differing from the estimate of 79,100,000 tons published last January by less than one half of 1 per cent. The value of this output was $184,653,498, an average of $2.32 per ton, a value slightly higher than the average in 1914. Compared with the figures for 1914 those for 1915 show a decrease of 2 per cent. in quantity and 1.9 per cent. in value. Anthracite is used mainly as a domestic fuel, and the mild weather during the early months of 1915 resulted in a decrease in consumption. A falling off in the exports to Canada, which normally takes a large quantity, and light buying by householders and retail yards in this country during the summer period of low prices, were also factors contributing to this decrease. There were 176,552 men employed in the anthracite mines in 1915, a greater number than in any year except 1914, when there were 179,679. The average number of days these men worked was 230, as compared with 245 in 1914, and the number of tons produced per man per year was 450, and per man per day 1.96, as against 451 tons per year and 1.84 tons per day in 1914. The smaller number of days worked, together with the comparatively large number of men employed, indicate that the work during the slack months was divided by the companies among a greater number of men than was necessary, in order to assist all. As in 1914, there were few strikes, only 30,325 men having been involved in 1915, for an average of 7 days each. There were 148 machines used in underground mining of anthracite in 1915, and 57 steam shovels were used on the surface, 1,001,431 tons having been taken from steam-shovel pits during the year. The steam shovels are nearly all used in the Schuylkill and Lehigh regions, and the mining machines in the Wyoming region.

GROUND has recently been broken for the building of the Museum of the American Indian in New York City. Mr. Archer M. Huntington has given to the institution a site with a frontage of sixty-five feet on Broadway, just south of 155th Street and adjacent to the group of buildings of which the Hispanic Museum is the center. The plans for the proposed museum provide for a structure with a basement and four stories, which will be in the same style as that of the building of the American Geographical Society. Friends of Mr. George G. Heye, who has gathered the notable collection which is to be placed in the structure, have subscribed $250,000 for the building, and arrangements are now being made to raise the additional $100,000 for the equipment. The collection itself, which includes 400,000 specimens and is valued at $500,000 is to be turned over in a few days to a board of trustees, who are also to take title to the real estate. Marshall H. Saville, of Columbia University, has been the scientific adviser of Mr. Heye for many years, and will be the director of the museum.

AMONG the courses in scientific field work provided for the coming summer quarter by the University of Chicago is one in geology

conducted in the region of Devils Lake, Wisconsin, the area studied covering about 300 square miles. The party is to camp at the north end of Devils Lake, near the center of the area studied, and the field work continues a month. After the field work a report is made, after the general plan of the United States Geological Survey. Another region for field work in geology is to be Ste. Geneviève County, Missouri, where are shown a large number of geological phenomena in a small area, as many as twenty distinct formations being exposed. Collections of fossils from the various formations will be made, which later may be used as the basis for laboratory study at the university. Another area designated for geological study during the summer quarter is that part of the Cascade Range between Mt. Hood and the Columbia River, where may be had first-hand acquaintance with valley glaciers, a great volcanic cone, recent lava flows and the records of at least six geological epochs. This course is open only to men who can "rough it," and the party is to meet at Portland, Oregon, on August 1, for a month's work. A field course is also to be given in the Lower St. Lawrence Valley, one of the most interesting regions geographically in eastern North America, where plain, highland and maritime conditions are often found in close proximity. Scenically also the region is famous, and Montreal, Quebec, French Canada and the eastern provinces afford many opportunities to relate geography to history as well as to present conditions. September will be given to this course and only graduate students can enter it.

UNIVERSITY AND EDUCATIONAL NEWS

At Yale University, Harry Nichols Whitford, B.S., Ph.D., has been appointed assistant professor of tropical forestry in the Forest School, and Alois Francis Kovarik, to be assistant professor of physics in the Sheffield Scientific School.

Dr. Percy Edward Raymond, assistant professor of paleontology in Harvard University, has been promoted to an associate professorship. Dr. Cecil Kent Drinker, of the Johns Hopkins Medical School, has been appointed instructor in physiology in the Harvard Medical School.

At Cornell University, the following promotions to the grade of professor have been made by the trustees: Sidney G. George, C.E., from assistant professor of applied mechanics; Frank O. Ellenwood, A.B., from assistant professor of power engineering; Calvin D. Albert, M.E., from assistant professor of machine design; Albert E. Wells, from assistant professor of machine construction; Lewis Knudson, Ph.D., from assistant professor of botany; Ralph W. Curtis, M.S.A., from assistant professor of landscape art; E. Gorton Davis, B.S., from assistant professor of landscape art.

Four graduate students of psychology have been appointed as fellows for the coming year in the Bureau of Salesmanship Research affiliated with the Carnegie Institute of Technology, as follows: Dwight L. Hoopingarner, of the University of Texas; C. P. Stone, University of Minnesota; Russell L. Gould, Columbia University; Edward S. Robinson, University of Cincinnati. In addition to these appointments, Dr. Kurt Th. Friedlaender, of San Francisco, has received appointment as honorary fellow.

DISCUSSION AND CORRESPONDENCE

RESULTS OF A STUDY OF DOLOMITIZATION

The writer believes that most dolomites were formed in the sea. Facts favoring this view are: (1) Dolomites and limestones are frequently interstratified. (2) Dolomitization is often related to original structures such as bedding, worm borings, etc., but rarely to faults and joints and other secondary structures. (3) Both mineralogical and chemical studies of limestones and dolomites show that limestones free or nearly free from dolomite, and dolomites nearly free from calcite are vastly more common than beds composed of mixtures of limestone and dolomite. If most dolomites had resulted from the action of underground waters, gradations between limestone and dolomite ought to be common. (4) Calcite fossil casts are often embedded in dolomite. Hollow casts are frequently enclosed by perfect dolo-

mite molds. In either case the calcitic shells evidently were deposited in a dolomite ooze. (5) Perfect dolomite rhombs are sometimes embedded in compact, horn-like calcitic beds. (6) Dolomitization bears no relation to the present pore space of beds as it probably would if it had been affected by underground waters.

That replacement was an important process in dolomitization is shown by the bunchy distribution of dolomite in mixed beds of dolomite and limestone, by the invasion of calcitic fossil casts by dolomite rhombs, and by local dolomitization adjacent to or within pervious marine structures, worm borings, shell cavities, etc. Dolomite grains in contact with calcite were all rhombohedral, but had no calcite inclusions. Anhedral form was the rule for dolomite grains in contact with their own kind. Certain facts suggest that dolomitization may take place by direct precipitation near the sea bottom, and by recrystallization of magnesia-bearing skeletons. Proof for the latter processes was not obtained.

Fossils and the shallow water structures of most dolomites show that, like most limestones, they were laid down in shallow warm seas. Salinity seems to have favored dolomitization, since dolomites are common in the enclosed basin deposits. Chemical and mineralogical studies show that dolomites contain isomorphously combined ferrous oxide. This shows positively that dolomites were laid down under reducing conditions.

The writer was able to differentiate calcite from dolomite very successfully with a modified form of the Lemberg solution consisting of 4 grams of fresh $AlCl_3$ crystals, 6 grams extract of logwood, 1,400 grams of water, boiled for 20 minutes with constant stirring and then filtered. Dolomite turns blue in a dilute solution of HCl about 1/10 normal with a few drops of freshly prepared potassium ferricyanide because of its ferrous iron content. Sedimentary calcite in all cases did not show a trace of ferrous iron.

EDWARD STEIDTMANN
GEOLOGICAL DEPARTMENT,
UNIVERSITY OF WISCONSIN

CELLOIDIN PARAFFIN METHOD

MANY of the difficulties encountered in sectioning hard and brittle objects (chitin, eggs with yolk, etc.) may be overcome by the use of a method which I find is not generally known or used in this country, and which I have been asked to publish in SCIENCE. It is the celloidin-paraffin method of Apáthy,[1] published by him in detail in 1912. Although long, this method combines the advantageous qualities of both the paraffin and celloidin methods, without introducing any disadvantages of either of these methods. There is no shrinkage as in the cooling of paraffin; ribbons can be cut and spread out on the slide by warming as with paraffin; thin sections may be cut even in warm weather, due to the firm nature of the infiltrated celloidin. The method consists of embedding the object in celloidin, clearing and dehydrating the hardened celloidin block, and then infiltrating with paraffin the celloidin block with its contained object. The chief advantage of Apáthy's technique lies in the use of his oil mixture, which is given below.

The method is as follows:

1. Fix, wash and dehydrate material in the usual way, finally putting through three changes of absolute alcohol.

2. Put into a tube of ether-alcohol at least 5 hours, keeping the object high in the tube. (Test tubes of various widths serve nicely for this, the object being held wherever desired by a loose plug of dry cotton wool inserted in the liquid.)

3. Two per cent. celloidin for twenty-four hours, deep in the tube.

4. Four per cent. celloidin for twenty-four hours, deep in the tube.

5. Put object into paper embedding box (or small dish) of four per cent. celloidin, and harden in chloroform vapor twelve hours.

6. Quickly trim excessive celloidin from the object, leaving a few millimeters on each side, and put deep into tube of chloroform for 12 hours.

7. Put into a tube of Apáthy's oil mixture

[1] Apáthy, S., 1912, "Neuere Beitraege zur Schneidetechnik," *Zeitschr. wiss. Mikr.*, Bd. XXIX., S. 449–515, 4 textfiguren.

until the block becomes clear and sinks; this may take from three days to a week. The oil mixture is as follows:

Chloroform by weight	4 parts
Origanum oil by weight	2 parts
Cedarwood oil by weight	4 parts
Absolute alcohol by weight	1 part
Carbolic acid crystals by weight	1 part

Put some dried sodium sulphate into the bottom of the tube to take up the water brought into the mixture by the celloidin.

8. Wash cleared block in three or more changes of benzol; this takes out oils and alcohol, and prepares for paraffin infiltration.

9. Infiltrate in paraffin, and embed. The temperature of the bath and long duration of infiltration will not cause shrinkage, as Apáthy states that blocks left in a bath at 70° C. for a week showed no shrinkage. To insure good ribbons I find a paraffin of medium hardness satisfactory in most cases, and leave a margin of pure paraffin about the celloidin-paraffin block when trimming. Where hard chitin is to be cut and the firmest possible block is desired, I use hard paraffin to infiltrate, and cut with a slanting knife on a sliding microtome.

10. Section and mount, using Mayer's fixative; then spread out and affix by warming as for paraffin sections. In staining on the slide, avoid leaving for any great length of time in xylol or absolute alcohol, as these liquids will dissolve the celloidin. A clearing oil instead of xylol may be used to advantage before the balsam. When objects stained in bulk are used, merely remove the paraffin in xylol and mount in balsam.

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THE ASPHYXIATION OF CANCER

Granting, at the present time, that early surgical removal is the most satisfactory method of curing cancer, there still remains the "hope which springs eternal in the human breast" of the scientist that a day will come when a successful non-surgical treatment of cancer may be realized. For centuries competent investigators have been seeking this goal, but without avail. With the exception of toxic gases, practically all of the possible chemical, physical and biological agents have been tried, including cell poisons, caustics, electricity, heat, light (visible and invisible rays), "vaccines," sera, and cell or organ extracts. The chief difficulty has been the finding of an agent which has a specific destructive action on the cancer cell without an injurious effect upon the surrounding healthy tissues. It must be admitted that a rational non-surgical treatment awaits the demonstration of a specific causal agent, or of a logical explanation of such an abnormality based on a thorough study of the chemistry and physics of protoplasm in general and of the living cell in particular.

A working hypothesis concerning the cause of cancer has been formulated by the writer after several years of theoretical and practical study. According to this hypothesis cancer is the result of localized, unchecked, over-combustion, or hyperoxidation, in epithelial cells; this condition is brought about by the concentrated, accelerated and uninhibited action of intracellular oxidizing enzymes, or their coenzymes, as a result of various injurious agents.

Based upon this theory, a rational treatment of the disease involves the inhibition of such "hyper-oxidations," or the complete asphyxiation of the cancer cells. This may be attempted indirectly by attacking the intracellular oxidizing enzymes (upon which cell oxidations, growth and multiplication so largely depend) or by renewing those enzymes in the body whose function it is to combat injurious cell oxidations. The direct asphyxiation of the cancer cell involves (1) the withholding of oxygen (so necessary for cell life) either by cutting off the blood supply or by absorbing the oxygen itself before it can be of service to the tumor cells; or (2) the introduction of sufficient carbon dioxid, or other toxic gases, to cause the suppression of oxidations in the tumor cells. It is evident that such a treatment must be confined to the cancer cells, for the general effect would be to kill all of the body cells. Herein lies the chief difficulty in its practical application.

Experimental work, involving the above

ideas, is now being carried on—the results of which will form the basis of future communications.

L. D. Bristol

University of North Dakota,
April 28, 1916

QUOTATIONS

BUSINESS MEN WHO WANT THE METRIC SYSTEM

Nothing gives so much hope that the metric system will some day be adopted in America as the work now being done in its behalf by the National Wholesale Grocers' Association. It is their type of support which alone can clinch the case in favor of the simpler standard. The theorists have done their best. They have proved conclusively what saving in time and labor, what gain in foreign trade, would follow upon the adoption of the metric system. Meanwhile, however, the country has been generally given to understand that practical men opposed the change, that they thought it would involve, while it was being made, insuperable difficulties to trade and manufacture. The wholesale grocers are practical men. In countless daily transactions their business would be directly affected by the change; they would have to undergo whatever hardships may accompany the shift in all its early days. And yet the grocers say they want the metric system.

Nor are the grocers content with wanting. They are also doing all they can to hasten the system's adoption, and in the measures they are taking, the country can see what ways may be followed in order to prepare for the change and make it, when it comes, less difficult. In pursuance of a report submitted by a special committee to the convention in Boston, every wholesale grocer is urged to print on the labels of all canned and boxed good not only the weight in English pounds and ounces, but also the metric equivalent. This custom will have two values. It will help to educate the American people in the metric system, and it will begin at once to reap the benefits for American goods abroad, especially in the South American countries, which a general adoption of the metric system promises. Furthermore, the grocers are preparing for their membership complete and easily used tables of equivalents, and are doing their utmost to show how the first year or two of the change might be rendered less difficult by their use.

Psychologically, also, the study which these practical men are making has its value to help explain why the American passion for liberty has never extended to open revolt against slavery to the old English tables. They show that children everywhere are being given a distaste for the metric system by the way it is presented to them in their study of arithmetic. Since the schoolbooks necessarily present it in relation to its equivalents in English weights and measures, it means no more for them than a new instrument of mental torture. Learned for itself alone, it would offer no more difficulty than the American money system gives the boy who learns it in a day, and almost without trying. Harnessed to the old English equivalents, its true simplicity is not revealed. From this poor start in school days, the American public appears to continue in amazing ignorance of the metric system's real value.

Very few men know, says the report to the grocers, what time it would save in commercial arithmetic and very few know the increasing pressure for its adoption brought by the needs of trade with countries which have it. If this be so, then the grocers' committee's proposal, that to their practical efforts there should be added an organization exclusively designed to educate the public on this subject, ought surely to be furthered.—*The Boston Transcript.*

SCIENTIFIC BOOKS

Who is Insane? By Stephen Smith, A.M., M.D., LL.D. The Macmillan Co., 1916.

Not the least remarkable thing about this very readable book is the fact that its author is a nonagenarian. Dr. Smith was the state commissioner in lunacy of New York from 1882 to 1888, and the present work largely embodies his observations during those years, together with the deductions of his long experience concerning the big questions of the prevention and treatment of mental disease.

The word of criticism which might be offered

that some of the clinical cases cited for illustration contain insufficient data to make them entirely convincing, loses some of its force perhaps, when it is recalled that the book is intended primarily for popular instruction, and to that end lapses naturally into the anecdotal style.

The author is delightful in his incorrigible optimism as to the hopefulness of treatment of insanity, crime and feeblemindedness under more rational conditions of organization and classification, and by more scientific methods than have hitherto existed. The general treatment of insanity he considers under three periods corresponding to the three tenses. The past was the period of mechanical restraint. The present is the period of custodial care. The future will be the period, let us hope, of curative treatment. The present, with all its humanitarian ideals and active therapeutic efforts is still the period of custodial care. We must perhaps admit it.

But the author looks ahead to the time when the state hospitals shall no longer be in the main simply repositories for the mentally infirm. He suggests that these institutions should comprise five definitely organized departments: (1) research, (2) curative, (3) industrial, (4) custodial, (5) hospital. The research and curative departments he would have under one administration consisting of an alienist, a physiologist, a pathologist, and a psychologist, together with field-workers and such other assistants as might be required. The plan as outlined is admirable, and already partially operative in many institutions. But Dr. Smith's forecast culminates in an ultra-optimism. "Might not the per cent. of 'discharged as cured' from our asylums be raised from twenty-five or thirty-three per cent. to eighty or ninety per cent., if all the resources of science, art and humanity were brought into requisition immediately on admission of each person legally committed as insane?" In the author's discussion it might seem that the environmental factors, important as they are unquestionably, are stressed too much, or rather that the endogenic factors are insufficiently stressed.

Excellent is the author's insistence upon the value of the work-cure in mental disease, and of the work-habit as prophylaxis, maintained onward into old age. "Retirement from business at this period, to enjoy the fruits of a life of toil, is to turn one's face towards the cemetery to which he will hasten with ever quickening step."

The nonagenarian physician evidently practises his own gospel, for now at ninety-three comes from his pen a book full of valuable and interesting material and fruitful suggestion, reflecting the youthful spirit of hopefulness and progress, rather than the retrospective sadness of a less efficient old age.

C. B. Farrar

Beekeeping. By E. F. Phillips, Ph.D. Rural Science Series. New York, Macmillan & Co. Pp. xxii + 457. 190 figs. Price $2.00.

We are living in an age of applied science; but the student of animal behavior is perhaps little concerned with the possible application of his branch of scientific inquiry. On this account the author's fundamental conception and mode of treatment are of particular interest. Beekeeping is applied animal behavior. As the author suggests, the well-informed beekeeper probably has a wider and more accurate knowledge concerning bees than have many students of animal behavior concerning the species with which they work. The successful beekeeper is, as we are told, the man "who has a knowledge of the activities of bees, whereby he can interpret what he sees in the hives from day to day, and who can mould the instincts of the bees to his convenience and profit." In this volume, therefore, the bee is treated as a living animal and special stress is laid upon its behavior and physiology in so far as investigations have thrown light upon these processes.

The United States Department of Agriculture is singularly fortunate in having as its chief expert in bee culture one so well fitted by the character of his training as Dr. Phillips, who has approached, from the standpoint indicated above, a subject which is perhaps more liable than most branches of agri-

cultural activity to be governed by individual preferences than by methods based on definite scientific principles. This is well illustrated in the case of the wintering of bees, which constitutes one of the most important questions for the practical beekeeper, particularly in the more northerly regions. As a result of the elaborate investigations which the author and his associates have conducted, the activities of the bees in the winter cluster and the factors affecting such activities have been brought out of the darkness, which heretofore, both literally and metaphorically, has hidden them from view, to the light of day so that they can now be described intelligently and the knowledge so acquired can be put to the greatest possible practical use. The fact that the temperature reactions of bees are so strong and so important from the practical standpoint demonstrates the value of the "behavior" point of view.

That a thorough knowledge of the behavior of the bee is essential is indicated by the fact that although bees have been kept by man from time immemorial they have not been domesticated; they have not, as Langstroth maintained, been tamed, but their natural instincts have remained unmodified. Consequently, the beekeeper must direct their instincts along the lines best adapted to his own ends. It is to the credit of American beekeepers that they have been so successful in this line of effort, for although it is undoubtedly true that, up to within recent years, the scientific knowledge of bees has been largely due to the work of European investigators, commercial beekeeping on a large scale is, as the author claims, "an American institution." The development of practical beekeeping began with the invention of the movable frame hive by Langstroth, the father of American beekeeping (1810–1895), and a comparison of the prevailing type of American hive, which is simple and useful for work, with the more elaborate British hive is significant.

All the important lines of work in the management of bees are fundamentally dependent upon a knowledge of their behavior. Honey production is the beekeeper's object, consequently he must so manipulate his bees that, when the nectar is available near his apiary, the bees may be in a condition to secure the maximum quantity. In this connection he should also possess some knowledge of the nectar-producing plants occurring in his neighborhood and in the localities in which he establishes his "out apiaries," and the period of their flowering, for this reason an annotated list of considerable length of nectar-producing plants is given and constitutes a valuable section of the book.

Ever since Dzierzon announced his theory that the drone is a product of an unfertilized egg, parthenogenesis in the bee has afforded both beekeepers and scientific workers a theme for much disputation. In beekeeping the question is of no little practical significance, especially to the breeder. The conclusion of Dr. Phillips on this point is of value, as he has devoted particular attention to the problem of parthenogenesis for a number of years. He does not feel that Dzierzon's conception that all the eggs in the ovary of the queen are male eggs is correct, but thinks that it is not improbable that the eggs destined to be females, that is, queens or workers according to their post-natal treatment, die for want of fertilization, while eggs destined to be males, not requiring fertilization, are capable of development. In view of what we now know concerning the biochemistry of fertilization the author's suggestion deserves serious thought. In no other insect is the question of sex determination of greater importance since the value of race is as important in beekeeping as in any other form of breeding.

With a few exceptions the existing books on beekeeping are little more than works of reference or books of rules. There was a distinct need for a work that was readable, based on scientific principles and eminently practical. Dr. Phillips has satisfied these requirements to a degree that it would be most difficult to surpass. His work is as admirable in the method of presentation as it is in the well-balanced treatment of all the many aspects of the subject. The illustrations are well chosen,

largely original and advisedly subordinated to the text. The Rural Science Series contains many valuable treatises, and although comparisons *are* invidious, none shows greater evidence of most careful writing in the face of an obvious necessity for compression. Beekeepers, both amateur and commercial, and teachers in agricultural colleges, are under a debt of gratitude to the author of this book; if it does not come to be regarded as the standard handbook on the subject on this continent we shall be greatly surprised.

C. Gordon Hewitt

A VALUABLE UNPUBLISHED WORK ON POMOLOGY

Most horticulturists are doubtless familiar with "A View of the Cultivation of Fruit Trees of America," published in 1817 by William Coxe, of Burlington, N. J., who has been called "The Father of American Pomology," but probably few are aware of the existence of an unpublished book of colored drawings of the fruits that were illustrated in this work by wood cuts. On pages 225–226 of the *Country Gentleman*, of Albany, N. Y., for April 2, 1857, there was published by E[dmund] L[aw] R[ogers], Baltimore, Md., an account of the activities of Mr. Coxe, in which it is stated that he had intended publishing a second edition of the work, accompanied by colored engravings for which natural-size water-color drawings had been prepared by his daughters. The publication of this second edition was prevented by Mr. Coxe's death in 1831. About twenty years ago this article came to the attention of Mr. William A. Taylor, then assistant pomologist of the U. S. Department of Agriculture, and a number of letters were written in an effort to locate the colored drawings, but without success. The matter was then dropped until the spring of 1915 when, in a conversation regarding some old horticultural catalogs, Mr. Taylor related these facts to the writer who suggested that it might still be possible to locate the unpublished colored plates through methods used by genealogical research workers.

The search was begun by looking up at the Library of Congress historical and genealogical works which might give information regarding the descendants of William Coxe, with the result that a list of his children was obtained, with some of their marriages. From this it was learned that Philadelphia and vicinity was at present the most likely locality to search for his descendants. Addresses were obtained of several of the Coxe family in that vicinity and a form letter sent to all of them giving the object of the inquiry, with the result that a chart of this branch of the family, only recently published, was secured by the writer. This gave the names of all descendants to date, but without addresses, although the places of births were usually given. With this clue several city and telephone directories were consulted and addresses of most of the descendants obtained. About twenty-five copies of the form letter were then sent to these addresses with the almost immediate result of six replies giving the address of the probable possessor of the work, followed the next day by a letter from one of the twenty-five addressed acknowledging the possession of the work.

It is with great pleasure that announcement is made of the donation of the unpublished colored drawings of fruits to the Library of the U. S. Department of Agriculture by the grandchildren of Mrs. Elizabeth (Coxe) McMurtrie, a daughter of William Coxe, by whom most of the paintings were made. The drawings are bound and in an excellent state of preservation. The character of the work shows a high degree of skill on the part of the artist in depicting fruits; and the positive identification of all the earlier descriptions and illustrations, some of which have long been in doubt, will now be possible. The work has been placed in a fireproof building and it is expected that the additional safeguard of a fireproof safe for this and similar books will be provided at an early date.

The drawings are accompanied by the bound manuscript upon which the published work was based, to which have been added numerous notes intended for a second edition. Many of

the notes bear dates ranging from 1810 to 1828 and it probable that the water-color work was largely done in the early part of this period, for several varieties are illustrated which according to the manuscript did not live long, or were destroyed as being of little value or particularly subject to disease.

In this connection it may be of interest to pathologists to call attention to early records which the manuscript and drawings contain relating to plant diseases, some of which were not described or apparently were but little known at that time to botanists or mycologists, and one of which at least was not recognized until fifty years later. There were few mycologists in this country or Europe at that early period and many diseases were not of sufficient economic importance to attract their attention. In fact most of the growers, if they paid any attention to fruit spots at all, considered them a part of the fruit. Many of the diseases now well known were doubtless of common occurrence even then, and perhaps much earlier. Microscopes of any decided magnification were then unknown, and scientists of those days can hardly be blamed for failing to make such observations.

In Coxe's published work of 1817 but one disease is mentioned, the fire blight of the pear (*Bacillus amylovorus* (Burr.) De Toni) which evidently then as now was a serious disease towards the eradication of which but little progress apparently has been made in the 100 years which have followed. In the season of 1915 which was unusually wet, this disease swept over a large part of the apple-producing section of the country, doing great damage to the trees. Stevens and Hall state[1] that this has been known over 100 years. It is probable that much earlier records could be found by the examination of older literature. The organism that causes the blight was not described until 1888.

In the unpublished colored drawings and the manuscript accompanying them are found descriptions or very accurate colored illustrations of the following fungous diseases:

[1] Stevens, F. L., and Hall, J. G., "Diseases of Economic Plants," 101, 1910.

Leaf Blight (*Fabræa maculata* (*Lev.*) *Atk.*).—The species was first issued in exsiccati by Léveillé in 1843 as *Entomosporium maculatum* and described somewhat later. The characteristic fruit spots are well depicted on both the pear and apple.

Pear Scab (*Venturia pyrina Aderh.*).—This was for many years confused with the apple scab and was not separately described until 1896.

Apple Scab (*Venturia inæqualis* (*Cooke*) *Winter*).—This was first described under *Sphærella* by Cooke in 1871.

Flyspeck of Apple (*Leptothyrium pomi* (*Mont. & Fr.*) *Sacc.*).—This was first described under *Labrella* in 1834. The sooty blotch (*Phyllachora pomigena* (Schw.) Sacc.) according to Duggar is only one stage of the flyspeck, and was first described by Schweinitz under *Dothidea* in 1832. Both are well illustrated on a number of varieties of apples.

Bitter Rot (*Glomerella rufomaculans* (*Berk.*) *Spauld. & Von Schrenk*).—This was first described by Berkeley under *Septoria* in 1854. Spaulding and Von Schrenk did not discover an earlier reference to the disease. In the Coxe manuscript under date of May 30, 1829, the bitter rot is referred to as common, with the statement that the author had been told by John Hoskins the elder that slaked lime was a good remedy for the disease. In accordance with this suggestion he spread a peck of slaked lime around each of 21 apple trees and worked it into the soil. No notes were made as to results, owing to his early death.

Fruit Spot (*Cylindrosporium pomi Brooks*). This disease is well illustrated on several varieties of apples and has been identified beyond question by Mr. Brooks. The disease was first discovered by Brooks in 1896. He states that it was first reported in Germany by Sorauer in 1879 and in this country by Jones in 1891. It was evidently not previously distinguished from the bitter rot.

Peach Scab (*Cladosporium carpophilum Thüm.*).—This was first described by von Thümen in 1879.

Probably other fungi are figured on the vari-

ous fruits but none that can be identified with accuracy.

A reference is also made in the manuscript to worms around the roots of peach trees which are said to cause an exudation of gum. This probably refers to the larvæ of some boring insect. An attempt was made to get rid of them by applying a handful of salt around the roots once or twice a season with the only result, however, that the larvæ were more numerous after the application than before.

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SPECIAL ARTICLES

THE INVERSION OF MENTHONE BY SODIUM, POTASSIUM AND LITHIUM ETHYLATES, AND A METHOD OF ANALYSIS FOR METHONE IN PINE OILS

THE work of Tubandt[1] has shown that the reaction

$$l\text{-menthone} \rightleftarrows d\text{-menthone}$$

can be followed polarimetrically, is monomolecular and is catalyzed by acids and bases. The present study has involved the measurement of the velocity of the inversion when brought about by sodium, potassium and lithium ethylates in absolute ethyl alcohol at 25°; a special constant temperature bath, holding silver-plated copper polarimeter tubes, has been employed.

The molar constant, K_N, found for the activity of the three ethylates at dilutions ranging from $N/32$ to $N/512$, were substituted in the equation $K_N = K_i\alpha + K_m(1-\alpha)$, derived by one of us[2] to express the activity of both the non-ionized molecules and the ions of a reacting electrolyte, and gave series of satisfactory constants for the activity of both the ethylate ions, K_i, and the non-ionized molecules K_m, of each ethylate.

It was found that the constant expressing the activity of the ethylate ion was the same, whether calculated from the data for sodium, potassium or lithium ethylate: for $NaOC_2H_5$, $K_i = 0.501$; for KOC_2H_5, $K_i = 0.501$, and for $LiOC_2H_5$, $K_i = 0.496$. The constants for the reactivity of the non-ionized ethylate were found to be very nearly the same for sodium and potassium ethylates, but somewhat lower in the case of lithium ethylate, as has been found to occur with other reactions. Thus, for $NaOC_2H_5$, $K_m = 0.693$; for KOC_2H_5, $K_m = 0.701$, and for $LiOC_2H_5$, $K_m = 0.478$.

The relative magnitudes of these constants agree with the fact that the molar constant, K_N, drops off with dilution for sodium and potassium ethylates, but does not change with dilution in the case of lithium ethylate; that the molar constants for sodium and potassium ethylates are close to one another in value, but different from those for lithium ethylate; and, finally, that the reaction velocity constants become practically the same for all three ethylates in the very dilute solutions in which the metallic ethylate is nearly completely ionized.

Having shown above that sodium, potassium and lithium ethylates cause the inversion of menthone, it was thought important to use this as an analytical method to determine the presence of menthone, and its amount, in certain pine oils said to contain the levo form of this material. Eight per cent. absolute alcoholic solutions of pine oil and of several of its fractions were made. These contained also N/64 sodium ethylate. These solutions showed no appreciable change in optical rotation in about three hours. In order to prove that no l-menthone was present in the pine oil an alcoholic solution containing 2 per cent. of partly inverted l-menthone and 8 per cent. of the same pine oil, or of its fractions, and $N/64$ sodium ethylate, was found to give the usual change in rotation observed for alcoholic solutions of l-menthone. It is clear, then, that pine oils have no appreciable influence on the change of rotation of admixed l-menthone and that the amount and rapidity of change of rotation by a given concentration of sodium, potassium or lithium ethylate can be used as a measure of the amount of d- or l-menthone in pine oil in excess of any amount of the equilibrium mixture of d- and l-menthone. If there is an excess of l-menthone present its effect on the rotation may be offset by other constituents hav-

[1] *Ann.*, 339, 41, 1904.

[2] *Am. Chem. Jour.*, 48, 359, 1912.

ing an opposite rotation. For example, *l*-borneol acetate with a specific rotation of — 44.4° could yield ethyl acetate and borneol with a specific rotation of — 37.8° *l*-menthol acetate, with a specific rotation of — 79.4°, yields *l*-menthol having a specific rotation of — 50°. The change of rotation in these two cases is in the same direction as that of *l*-menthone and would be added to it. In other cases, however, the changes might be in the opposite direction. The change in rotation due to the borneol acetate, for example, can be calculated from the ester number, which is always determined, and the proper correction can be made.

The same idea can be applied to the calculation of the amounts of each of two esters whose identities are known and whose changes of rotation by sodium ethylate are different or of opposite sign. The ester number and change of rotation will give the amount of each. When the mixtures become complex the "unknowns" become too large and the method becomes only qualitative at best.

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MEASURING BIOLOGICAL ACTIONS BY THE FREEZING-POINT METHOD DIRECTLY IN THE SOIL

IT has already been shown that the freezing-point method can be employed to measure (*a*) the concentration of the plant-cell sap directly in the plant tissue,[1] (*b*) the concentration of the soil solution at different moisture contents, directly in the soil,[2] and (*c*) the effect of application of soluble chemical compounds upon the soil solution.[2] In the present note it is desired to announce that the freezing-point method can be used also to study biological activities, by measuring the products of decomposition of organic materials, directly in the soil.

In conjunction with the experiments on the effect of the application of soluble chemical compounds upon the concentration of the soil solution, the effect of the decomposition of various nitrogenous substances was also studied. It has been found that the products of decomposition of these nitrogenous substances increased markedly the concentration of the soil solution, and the magnitude of the increase varied with the nature of the compound and amount employed. In the following table there are presented the results of a single experiment which might serve to typify the character of the general data obtained. This experiment consisted of mixing 0.5 and 1.0 grams of dried blood, cotton-seed meal and animal tankage with 800 grams of soil (equivalent to about 1,250 and 2,500 pounds per 2,000,000 pounds of soil respectively), allowing the mixture to stand in room temperature for five weeks at optimum moisture content and then determining the freezing-point depression, according to the method already described in Tech. Bull. No. 24 of this Station. The percentage of nitrogen contained by the materials is as follows: dry blood, 14.14 per cent.; cotton-seed meal, 7 per cent., and animal tankage, 10 per cent.

TABLE I

Effect of Decomposition of Nitrogenous Substances Upon the Freezing-Point Depression of the Soil Solution

Substance	Grs.	Depression Due to Substance
Dry blood	0.5	.025° C.
" "	1.0	.050°
Animal tankage ...	0.5	.020°
" " ...	1.0	.040°
Cotton-seed meal ...	0.5	.017°
" " " ..	1.0	.030°

The depression in every case is the difference between the depression of the untreated soil or check and that of the treated. In other words, the check was used as a standard.

It will be seen then that the decomposition of these nitrogenous materials increased the depression, and hence the concentration of the soil solution, markedly, and the magnitude of the increase seems to vary with the nature of the material and quantity employed.

In some other experiments the amounts of these nitrogenous materials were used, not in equivalent weight but in equivalent nitrogen content and the freezing-point depression was

[1] *J. Am. Soc. Agr.*, Vol. 8, No. 1, 1916.

[2] Tech. Bull. No. 24, Mich. Expt. Sta., 1916.

measured at various intervals. The results show that dried blood reached its maximum decomposition first, followed by animal tankage and cotton-seed meal, respectively.

The study of soil bacteriology at present consists mainly of either measuring the number of bacteria in the soil, or the kind and intensity of functions of the bacteria. The former study is usually designated as *taxonomic* and the latter as *physiological*.

The taxonomic method is at present not much used in the bacteriological studies of soils, because it has failed to furnish very satisfactory results. The physiological method, however, has proven more successful, at least from the practical standpoint, and is consequently more widely employed.

As already stated, the physiological method aims to measure the kind and physiological efficiency of the organisms by measuring the product of their action upon nitrogenous substances. The products resulting from the decomposition of the nitrogenous materials consist principally of ammonia, nitrite, nitrate amino compounds, etc. Unfortunately the present methods for measuring these end products are for the most part unsatisfactory.

From the results obtained thus far by the freezing-point method on the decomposition of organic materials in soil, it seems possible that this method may be used to great advantage in conducting physiological studies. It is true that the method gives only the total amount of the decomposed soluble material and tells nothing as to the composition of the product. But is not the amount of ammonification, nitrification, etc., taken as criterion of the decomposibility of the substance and the physiological efficiency of the organisms? So may the total depression be taken to represent the same criterion. The decomposition products will undoubtedly exert a solvent action upon the mineral constituents of the soil, and thus influence the total depression. There are evidences, however, which go to indicate that this influence is small (aside from the chemical combination) and consequently the error would be comparatively insignificant. On the other hand, the study will be only comparative.

It appears that the freezing-point method may be used to great advantage in making comparative studies of the decomposibility of various organic substances, in the same kind of soil, or the decomposing power of different classes of soil on the same organic substance, or of the same soil differently treated, etc. Such studies can be conducted very conveniently, under the most natural conditions, and the results thus obtained will doubtless lead to very important and true conclusions concerning the availability of various nitrogenous materials, decomposing power of soils, etc.

Studies along these lines are now being conducted in the laboratory.

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THE SYNONYMY OF OXYURIS VERMICULARIS, THE PIN WORM OF THE HUMAN INTESTINE

In 1758 Linnæus described the pin worm of man under the name of *Ascaris vermicularis*. In 1803 Zeder transferred it to the genus *Fusaria* (*Ascaris* renamed). In 1819 Bremser placed it in *Oxyuris* (type *O. equi*). Baird in 1853[1] published a manuscript name of Leach's *Enterobius vermicularis*.

The species has been generally called *Oxyuris vermicularis* until Stiles in 1905 gave it the generic name of *Oxyurias*, overlooking Leach's name. Now Seurat in 1916[2] proposes the name *Fusarella*, evidently being unaware of the generic names it has received subsequent to *Oxyuris*.

The species clearly does not belong in the same genus with *Oxyuris equi*, and as *Enterobius* is the earliest generic name available, the name of the species is *Enterobius vermicularis* (Linnæus, 1758) Leach, 1853.

Albert Hassall
Zoological Division,
Bureau of Animal Industry,
U. S. Department of Agriculture

1 "Catalogue of the Species of Entozoa, or Intestinal Worms, Contained in the Collection of the British Museum," p. 108.

2 *Compt. rend. Soc. de biol., Par.*, Vol. 79, p. 67.

THE IOWA ACADEMY OF SCIENCE

THE Iowa Academy of Science held its thirtieth annual session with Drake University, Des Moines, April 28 and 29, 1916. In the number of papers presented this meeting exceeded any previous session, a fact which speaks well for the scientific activity of the students and investigators of the state. The academy followed the plan instituted last year of having most of the papers presented before sectional meetings, of which there were three—1, Chemistry; 2, Physics; and 3, Botany, Geology and Zoology.

In the evening of the twenty-eighth Dr. Louis Kahlenberg of the University of Wisconsin gave the annual address before the Academy on "Some Results from the Experimental Study of Osmosis."

The Iowa and Ames sections of the American Chemical Society met with the Academy and an Iowa section of the Mathematical Association of America was organized during the meetings.

The following were the officers elected to serve during the coming year.

President: G. W. Stewart, State University.

First Vice-president: L. S. Ross, Drake University.

Second Vice-president: Miss Alison E. Aitchison, State Teachers College.

Secretary: James H. Lees, Iowa Geological Survey.

Treasurer: A. O. Thomas, State University.

PROGRAM

Abstracts are by the authors

Barium in Tobacco and Other Plants: NICHOLAS KNIGHT.

A number of samples of tobacco were examined and a small quantity of barium found in each one. The samples were obtained from Sumatra, Cuba and from various sections of the United States. Thirteen samples of leaves of common trees were also examined, and a sample of the soil in which they grew.

Pure Sodium Chloride: NICHOLAS KNIGHT.

Samples of common salt were made by four different methods, and small amounts of potassium chloride were found in each sample. Similar results were obtained from three samples of "C.-P." sodium chloride.

Some Rock Analyses: NICHOLAS KNIGHT.

An Improved Method of Determining Solubility: W. S. HENDRIXSON.

Acid Potassium and Sodium Phthalates as Standards in Acidimetry and Alkalimetry, II.: W. S. HENDRIXSON.

Some Auxoamylases: E. W. ROCKWOOD.

Electromotive Forces and Electrode Potentials in Pure and Mixed Solvents, II.: F. S. MORTIMORE and J. N. PEARCE.

The Behavior of Solutions at the Critical Temperature, a Preliminary Report: PERRY A. BOND.

A Comparison of Barbituric Acid, Thiobarbituric Acid and Malonylguanidine as Quantitative Precipitants for Furfural: A. W. DOX and G. P. PLAISANCE.

An Accurate Aeration Method for Determining Alcohol in Fermentation Mixtures: A. W. DOX and A. R. LAMB.

Relative Influence of Bacteria and Enzymes on Silage Fermentation, Preliminary Report: A. R. LAMB.

Estimation of Calcium in Ash of Forage Plants and Animal Carcasses: S. B. KUZIRIAN.

The Pleasant Ridge Group of Effigy Mounds: ELLISON ORR.

These mounds are included in the proposed Mississippi Valley National Park. This park will include a strip of land along the bluffs from a point about six miles south of McGregor, Iowa, to the mouth of Yellow River, about three miles north of McGregor. This group of mounds lies on a very high point of the bluff about half way between McGregor and the mouth of Yellow River, and is comprised of some eight or nine animal mounds and three bird mounds, all in a good state of preservation.

An Old Roman Coin in South Dakota: DAVID H. BOOT.

Contributions to the Geology of Southwestern Iowa: GEORGE L. SMITH.

A Note on Fulgurites from Sparta, Wisconsin: W. D. SHIPTON.

A New Stratigraphic Horizon in the Cambrian System of Wisconsin: W. D. SHIPTON.

Records of Oscillations in Lake Level, and Records of Lake Temperature and Meteorology Secured at the Macbride Lakeside Laboratory, Lake Okoboji, Iowa, July, 1915: JOHN L. TILTON.

Tidal effects were almost zero, barometric effects too small to be detected without magnification, and intake and outflow about equal. Wind effects were noticeable and quickly compensated by movement in the lake. The wind directed the circulation in the lake. The division of the lake water into

"Axone Hillock" of Crayfish Nerve Cell (illustrated): L. S. Ross.

A Malignant Tumor of a Chicken Liver, a Demonstration: L. S. Ross.

Notes on Two Strawberry Slugs: R. L. Webster.

An account of two strawberry insects that have been frequently confused in the literature of economic entomology.

A Method of Preparing Studies of Trichinella spiralis Owen: Dayton Stoner and Thesle T. Job.

Life History and Habits of the Gold-banded Paper Maker, Polistes metrious Say: Frank C. Pellett.

Distributional Notes on Some Iowa Pentatomoidea: Dayton Stoner.

An Hermaphrodite Crayfish: Ivan L. Ressler.

The White Admiral or Banded Purple Butterfly in Iowa: B. O. Wolden.

Notes on the Little Spotted Skunk: B. H. Bailey.

Successful Mink Farming in Iowa: B. H. Bailey.

A Handy Device for Staining Slides: E. Lawrence Palmer.

The simple staining apparatus demonstrated was devised to take the place of the more expensive staining jars sold by most of the scientific supply houses. Besides the cheapness of the outfit, which fits into any tumbler, there is the added advantage that all of the slides being stained may be removed from the jar at once and may be rinsed while still in the frame. Fourteen slides may be inserted into the frame at one time, which is four more than the average staining jar holds.

The device is made by bending eight strips of zinc 15 × 200 mm. into the channels (*a*). These are soldered to the 20 × 140 mm. zinc strip (*b*) which is then bent into a rectangular form with the channels on the inside. The strip (*c*) 1 × 26 cm. is then soldered to the ends of the strip (*b*), forming a handle with which to lift the frame, and a guard to prevent the slides from falling out at the bottom.

This piece of apparatus has proved particularly handy in staining work where most of the slides require the same treatment.

A Seed Key to Some Common Weeds and Plants: E. L. Palmer.

This preliminary key to the seeds and fruits of one hundred and eighteen of the common weeds and plants of northeastern United States uses external characters as a basis for classification and arranges the seeds according to size. Most keys are made on a strict dichotomous plan. In this case, however, those seeds whose length is between 1 and 2 mm., between 2 and 3 mm., etc., are considered separately. After this step, one finds the key on a strict dichotomous plan. The possibility of entering the key at a number of places lessens the number of decisions to be made in determining the individual and consequently increases the probability of correct determination. Besides detailed descriptions of all the seeds mentioned in the key, there are pen and ink sketches of forty-one of the more typical forms considered.

The Growth of Legumes and Legume Bacteria in Acid and Alkaline Media: R. C. Salter.

A Forest Census in Lyon County, Iowa: David H. Boot.

The Preservation of Fleshy Fungi for Laboratory Use: Guy West Wilson.

Notes on some Peliate Hydnaceæ from Iowa: Guy West Wilson.

Scleroderma vulgare and its Allies: Guy West Wilson.

Some Observations on California Plants: L. H. Pammel.

Some Observations on the Weeds of California: L. H. Pammel.

A Record of Fungus Diseases: L. H. Pammel and Charlotte M. King.

How a Tree Grows: Fred Berninghausen.

Notes on the Pollination of Some Plants: Robert L. Post, presented by L. H. Pammel.

Notes on Anatomy of the Leaves of Some of the Conifers of North America: L. W. Durrell, presented by L. H. Pammel.

Notes on the Flora of Sitka, Alaska: J. P. Anderson.

Notes on a Cultivated Elodea: R. B. Wylie.

Insect Pollination of Frasera stenosepala: L. A. Kenoyer.

Insect Pollination of Timber Line Plants in Colorado: L. A. Kenoyer.

Pioneer Plants on a New Levee, II.: Frank Thone.

The paper is a condensed summary of late developments on the area discussed in a paper presented at the 1915 meeting of the academy.

The Control of the Oats Smut by Formalin Treatment: J. A. Krall.

Late Blight Epidemics in Iowa as Correlated with Climatic Conditions: A. T. Erwin.

The Sand Flora of Eastern Iowa: B. SHIMEK.

The sandy areas in Muscatine and Louisa counties are chiefly discussed. The number of species peculiar to the sands of this region is small, the greater part of the flora being that of the prairies. Notes on seasonal succession on these areas are included.

The White Waterlily of Iowa: HENRY S. CONRAD.

The paper describes the variations of *Nymphæa odorata*, and gives in parallel columns the distinctions between this species and *Nymphæa tuberosa*. It questions the identification of all the waterlilies from the Great Lake region and the Central States, and asks for fuller study to determine the taxonomic value and the range of these forms.

A Section of Upper Sonoran Flora in Northern Oregon: MORTON E. PECK.

The paper gives first a brief account of the climatic conditions, topography, etc., in the neighborhood of Umatilla, Oregon. The several plant associations, with the areas they cover, are next described. The discussion closes with a complete annotated list of the species of seed plants known to inhabit the area under consideration.

JAMES H. LEES,
Secretary

DES MOINES, IA.

THE KENTUCKY ACADEMY OF SCIENCE

THE Kentucky Academy of Science held its third annual meeting at Lexington, in the lecture room of the physics department, University of Kentucky, May 6, 1916, President N. F. Smith in the chair.

After a business session at which a number of new members were elected, and among other things a resolution was passed favoring the adoption of the bill now before Congress requiring the use of the Centigrade thermometer scale in government publications (H. R. 528), the following program was carried out:

President's Address—Problems and Progress of Twentieth-century Physics: N. F. SMITH.

Twentieth-century physics had its birth in the year 1895, when Roentgen discovered the new form of radiation known as X-rays. There followed rapidly after this a succession of important discoveries chiefly connected with radio-activity. From the many new facts discovered there has gradually developed the electronic theory of matter and electricity. It has been definitely established that every electric charge is made up of an exact number of elementary electric charges or atoms of electricity. The magnitude of this elementary electric charge has been determined with great accuracy. From the value of this elementary charge other important physical constants can be accurately determined, among them the mass of an electron, and the masses of different atoms. It has been shown that every electric current is a convection current; the inertia of matter is probably entirely due to its electrical nature and is analogous to self-induction. It has been shown that X-rays are of the same character as light, but with a wave-length about one-ten-thousandth part as great. This has been established by the use of crystals as a diffraction grating. A reasonable theory of the structure of the atoms of the different elements has been established which is in close agreement with observed facts. The electromagnetic theory, as worked out by Maxwell, is incomplete and requires important modification to account for the facts of radiation. On the whole, remarkable progress has been made in the development of physical theory.

Astronomy Applied in Archeological and Historical Research: HENRY MEIER.

The author had collected a large number of events and circumstances mentioned in works on ancient history and given in ancient Greek or Roman classics, which events referred to a probable total eclipse of the sun or moon taking place about the time given and visible in the regions referred to. He then calculated the times of all possible eclipses for the time and place of each event and having thus established accurately the year, month and day of the event given by history he was enabled to determine with certainty other historic dates related to the event.

Likewise from the accurately measured orientations of certain ancient temples in Upper Egypt dedicated either to the sun or to a well-known star, he determined, based upon the facts that the obliquity of the sun's ecliptic is a variable quantity and that the declinations of fixed stars change from year to year, the probable time of construction of each temple, and thus he was able to fix chronologically the events related through inscriptions in each temple.

Some Historic Fish Remains: ARTHUR M. MILLER.

When the writer took charge of the department of geology, State College, in 1892, he found stored in the basement of the old Chemistry Building, some interesting fossil fish remains. He later found that

the labels pasted on them containing the initials "J. S. N." were placed there by J. S. Newberry and that these were the identical specimens described in Vol. 1, Paleontology of the Ohio Geological Survey, under the names *Orodus* and *Ctenacanthus* from the "Waverly Shale" exposed at Vanceburg, Ky. It was the finding in this deposit of the teeth of the fish which had been named *Orodus* in such close juxtaposition with the spines of the fish which had been named *Ctenacanthus*, that led Professor Newberry to conclude that these two structures belonged to one and the same species.

Reference was made to a previous account of these remains given by Professor Andrews in a volume of the Ohio Survey published in 1870 on work done in 1869, in which these specimens were credited to a Captain James Patterson, who found them in the Upper Black Shale (Sunbury Shale) at Vanceburg, Ky.—presumably in the course of quarrying the shale for oil distillation, an industry started in this country in the fifties or sixties of the last century, but speedily abandoned, when the discovery by Silliman, of Yale, led to the obtaining of paraffin more cheaply from petroleum.

Comment was made in this connection on how paleontology is indebted to commercial operations for some of its more interesting fossil remains.

A New Form of Frequency Meter: N. F. SMITH.

A rotating disc marked off in sectors alternately black and white is illuminated by an A. C. arc light. Since the light comes principally from the positive carbon, the illumination of the disc is intermittent. Therefore a stroboscopic effect is produced, and with proper speed of rotation the disc appears to stand still. From the rate of rotation of the disc, the frequency of the current is at once determined.

The Dr. Robert Peter Herbarium of the University of Kentucky: FRANK T. MCFARLAND.

The paper shows the value of the Peter Herbarium as compared with the herbarium of the University of Kentucky.

In the University of Kentucky Herbarium are 4,106 specimens, of which 3,157 were collected by Dr. Robert Peter and Dr. Charles W. Short, of Lexington, from 1832 to about 1835. For the state, Dr. Peter has listed a total of 1,205 species, but only 470 mounted species are in the Herbarium. Only 592 species for the state are listed in the University of Kentucky Herbarium, with which the Peter Herbarium is consolidated, much fewer than the actual number in the state.

"Stem Rot" of Alfalfa and Clovers Caused by Sclerotinia Trifoliorum, Erik: ALFRED HOLLEY GILBERT.

The paper contains reference to previous observations, as reported in Kentucky Experiment Station Circ. No. 8, 1915; also a brief résumé of the history of the disease in Europe and America, and a report of a recent attack upon crimson clover in Kentucky.

Since the causal organism is a soil fungus and sclerotia may remain in the soil, retaining their vitality, possibly, for several years, a rotation of crops in which no one of the several legumes which serve as hosts for the fungus is grown for at least three years, is recommended as a control measure. The host plants so far as known are all the cultivated clovers and alfalfa. A common weed, *Abutilon*, was also observed to act as a host plant.

On the Distribution of Phosphorus in a Section of Bluegrass Soil: ALFRED M. PETER.

Analyses of soil samples from each 6 inches, from the surface to the rock, showed strikingly different percentages of phosphorus, ranging from 0.258 in the second to 6.692 in the twentieth 6 inches, with other maxima in the fifteenth and twenty-fifth 6 inches.

These differences are similar in degree to those existing between different layers of the phosphatic Lexington limestone, and are accounted for by supposing that the calcium carbonate of the limestone has been dissolved away, leaving most of the phosphate in layers of greater or less richness, according as the limestone layers were more or less phosphatic.

Precipitation of Cobalt and Nickel Salts in Gels: C. A. NASH and JOHN ARDERY.

The following paper was read by title:

"Note on a Specimen of Radioactive Mineral," by J. W. Pryor.

At the afternoon session Dr. F. R. Moulton, of the University of Chicago, delivered an illustrated lecture on "Some Recent Discoveries in the Sidereal Universe," in which the present methods of determining the distances and motions of the fixed stars were explained in a popular way.

The election of officers was as follows: Professor A. M. Miller, president; Dr. Garnett Ryland, vice-president; Professor P. P. Boyd, treasurer; Dr. A. M. Peter, secretary.

About forty members of the academy were in attendance and a large number of guests.

A. M. PETER,
Secretary

SCIENCE

FRIDAY, JULY 21, 1916

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

THE NATURE, MANNER OF CONVEYANCE AND MEANS OF PREVENTION OF INFANTILE PARALYSIS[1]

THE Rockefeller Institute for Medical Research has been appealed to by so many physicians and laymen for information and advice on the subject of infantile paralysis, that it has seemed desirable to relate the facts of present knowledge concerning certain highly pertinent aspects of the disease, together with deductions of practical importance derived from them.

Nature

Infantile paralysis is an infectious and communicable disease which is caused by the invasion of the central nervous organs —the spinal cord and brain—of a minute, filterable microorganism which has now been secured in artificial culture and as such is distinctly visible under the higher powers of the microscope.

Location of the Microorganism or Virus in the Sick

The virus of infantile paralysis, as the microorganism causing it is termed, exists constantly in the central nervous organs and upon the mucous membrane of the nose and throat and of the intestines in persons suffering from the disease; it occurs less frequently in the other internal organs, and it has not been detected in the general circulating blood of patients.

Location of the Virus in Healthy Persons

Although the microorganism of infantile paralysis is now known, the difficulties attending its artificial cultivation and identification under the microscope are such as

[1] Substance of an address before New York Academy of Medicine, July 13, 1916.

to make futile the employment of ordinary bacteriological tests for its detection. Nevertheless, the virus can be detected by inoculation tests upon monkeys, which animals develop a disease corresponding to infantile paralysis in human beings. In this manner the fact has been determined that the mucous membrane of the nose and throat of healthy persons who have been in intimate contact with acute cases of infantile paralysis may become contaminated with the virus, and that such contaminated persons, without falling ill themselves, may convey the infection to other persons, chiefly children, who develop the disease.

Relation of Virus to Types of the Disease

The virus has, apparently, an identical distribution irrespective of the types or severity of cases of infantile paralysis. Whether the cases correspond with the so-called abortive forms of the disease in which definite paralysis of the muscles does not occur at all, or is so slight and fleeting as often to escape detection; whether they correspond with the meningeal forms in which the symptoms resemble those of acute meningitis with which muscular paralysis may or may not be associated; or whether they consist of the familiar paralytic condition, the virus is present not only within the nervous organs, but also upon the mucous membranes of the nose, throat and intestines.

Escape of the Virus from the Body

Microorganisms which convey disease escape from the body of an infected individual in a manner enabling them to enter and multiply within fresh or uninfected individuals in such a manner as to cause further disease. The virus of infantile paralysis is known to leave the infected human body in the secretions of the nose, throat and intestines. It also escapes from contaminated healthy persons in the secretions of the nose and throat. Whether it ever leaves the infected body in other ways is unknown. At one time certain experiments seemed to show that biting insects and particularly the stable fly might withdraw the virus from the blood of infected persons and inoculate it into the blood of healthy persons. But as the virus has never been detected in the blood of human beings and later experiments with the stable fly have not confirmed the earlier ones, this means of escape of the virus must be considered doubtful. On the other hand, it has been shown by experiments on animals, so that the same facts should be regarded as applicable to human beings, that the virus seeks to escape from the body by way of the nose and throat, not only when inoculation takes place through these membranes, but also when the inoculation is experimentally made into the abdominal cavity, the blood, or the brain itself. From this it is concluded that the usual means of escape of the virus is by way of the ordinary secretions of the nose and throat and, after swallowing these, with the discharges of the intestines.

Entrance of the Virus into the Body

The virus enters the body, as a rule if not exclusively, by way of the mucous membrane of the nose and throat. Having gained entrance to those easily accessible parts of the body, multiplication of the virus occurs there, after which it penetrates to the brain and spinal cord by way of the lymphatic channels which connect the upper nasal membrane with the interior of the skull. Whether the virus ever enters the body in any other way is unknown. Certain experiments already alluded to make it possible that it may be inoculated into the blood by insects, and other experiments have shown that under peculiar and extraordinary conditions, it may in mon-

keys enter through the intestines. But while the latter two modes of infection may operate sometimes, observations upon human cases of infantile paralysis and upon animals all indicate that the main avenue of entrance of the virus into the body is by way of the upper respiratory mucous membrane—that is, the membrane of the nose and throat.

Resistance of the Virus

The physical properties of the virus of infantile paralysis adapt it well for conveyance to the nose and throat. Being contained in their secretions, it is readily distributed by coughing, sneezing, kissing, and by means of fingers and articles contaminated with these secretions, as well as with the intestinal discharges. Moreover, as the virus is thrown off from the body mingled with the secretions, it withstands for a long time even the highest summer temperatures, complete drying, and even the action of weak chemicals, such as glycerin and carbolic acid, which destroy ordinary bacteria. Hence mere drying of the secretions is no protection; on the contrary as the dried secretions may be converted into dust which is breathed into the nose and throat, they become a potential source of infection. The survival of the virus in the secretions is favored by weak daylight and darkness, and hindered by bright daylight and sunshine. It is readily destroyed by exposure to sunlight.

Conveyance by Insects

Since epidemics of infantile paralysis always arise during the period of warm or summer weather, they have been thought of as possibly being connected with or dependent on insect life. The blood-sucking insects have especially come under suspicion. Experiments have been made with biting flies, bed-bugs, mosquitoes, and with lice. Neither mosquitoes nor lice seem able to take the virus from the blood of infected monkeys or to retain it for a time in a living state. In one instance, bed-bugs have been made to take up the virus from the blood of monkeys, but they did not convey it by biting to healthy monkeys. Certain experiments did indicate that the biting stable fly could both withdraw the virus from the blood of infected and reconvey it to the blood of healthy monkeys, which became paralyzed. But more recent studies have failed to confirm the earlier ones. Moreover, experimentally inoculated monkeys differ in one way from human beings suffering from infantile paralysis, for while the virus may appear in the blood of the former, it has never been detected in the blood of the latter. The ordinary or domestic fly may become contaminated with the virus contained in the secretions of the body and serve as the agent of its transportation to persons and to food with which they come into contact. Domestic flies experimentally contaminated with the virus remain infective for 48 hours or longer. While our present knowledge excludes insects from being active agents in the dissemination of infantile paralysis, they nevertheless fall under suspicion as being potential mechanical carriers of the virus of that disease.

Conveyance by Domestic Animals

The attention which the recent epidemic of infantile paralysis has drawn to the diseases attended by paralysis has led to the discovery that domestic animals and pets are subject to paralytic diseases. The animals which have especially come under suspicion as possibly distributing the germ of infantile paralysis are poultry, pigs, dogs, and cats. But in isolated instances, sheep, cattle, and even horses have been suspected. All these kinds of animals are subject to diseases in which paralysis of the legs and other parts of the body sometimes

appear. In not a few instances, paralytic diseases among poultry or pigs have been noted to coincide with the appearance of cases of infantile paralysis on a farm or in a community. Experimental studies have, however, excluded the above-mentioned animals from being carriers of the virus of infantile paralysis. The paralytic diseases which they suffer have long been known and are quite different from infantile paralysis. Their occurrence may be coincidental; in no instance investigated has one been found to be responsible for the other.

Routes of Travel

Studies carried out in various countries in which infantile paralysis has been epidemic all indicate that, in extending from place to place or point to point, the route taken is that of ordinary travel. This is equally true whether the route is by water or land, along a simple highway or the line of a railroad. In other words, the evidence derived from this class of studies confirms the evidence obtained from other sources in connecting the distributing agency intimately with human beings and their activities.

Survival of the Virus in the Infected Body

The virus of infantile paralysis is destroyed in the interior of the body more quickly and completely than, in some instances, in the mucous membrane of the nose and throat. It has been found in monkeys, in which accurate experiments can be carried out, that the virus may disappear from the brain and spinal cord within a few days to three weeks after the appearance of the paralysis, while at the same time it is still present upon the mucous membranes mentioned. The longest period after inoculation in which the virus has been detected in the mucous membrane of the nose and throat of monkeys is six months. It is far more difficult to detect the human than the monkey carriers of the virus since, as directly obtained from human beings, the virus displays a low degree of infectivity for monkeys; while, once adapted to monkeys, the virus becomes incredibly active, so that minute quantities are capable of ready detection by inoculation tests. Yet in an undoubted instance of the human disease, the virus was detected in the mucous membrane of the throat five months after its acute onset. Hence we possess conclusive evidence of the occurrence of occasional chronic human carriers of the virus of infantile paralysis.

Fluctuation in Epidemics

Not all epidemics of infantile paralysis are equally severe. Indeed great variations or fluctuations are known to occur not only in the number of cases, but also in the death rate. The extremes are represented by the occasional instances of infantile paralysis known in every considerable community and from which no extension takes place, and the instances in which in a few days or weeks the number of cases rises by leaps and bounds into the hundreds, and the death rate reaches 20 per cent. or more of those attacked. While all the factors which determine this discrepancy are not known, certain of them have become apparent. A factor of high importance is the infective power or potency, or technically stated the virulence, of the microorganism or virus causing the disease. This virus is subject to fluctuations of intensity which can best be illustrated by an example. The virus as ordinarily present in human beings even during severe epidemics has low infective power for monkeys. But by passing it from monkey to monkey, it tends to acquire after a variable number of such passages an incredible activity. However, occasional samples of the human virus refuse to be thus intensified. But once rendered

highly potent, the virus may be passed from monkey to monkey through a long but not indefinite series. Finally, in some samples of the virus at least a reverse change takes place—the virus begins to lose its virulence until it returns to the original or even to a diminished degree of infective power. In this respect the behavior of the virus corresponds to the onset, rise and then the fall in number and severity of cases as observed in the course of epidemics of infantile paralysis and other epidemic diseases. Hence either a new active specimen of the virus may be introduced from without which, after a certain number of passages from person to person, acquires a high potency; or a specimen of virus already present and left over from a previous epidemic after a resting period and similar passages, again becomes active and reaches an infective power which equals or even exceeds that originally possessed. Another but more indefinite factor relates to the degree of susceptibility among children and others affected which at one period may be greater or less than at another.

Varying Individual Susceptibilities

Not all children and relatively few adults are susceptible to infantile paralysis. Young children are more susceptible generally speaking than older ones; but no age can be said to be absolutely insusceptible. When several children exist in a family or in a group, one or more may be affected, while the others escape or seem to escape. The closer the family or other groups are studied by physicians, the more numerous it now appears are the number of cases among them. This means that the term infantile paralysis is a misnomer, since the disease arises without causing any paralysis whatever, or such slight and fleeting paralysis as to be difficult of detection. The light or abortive cases, as they are called, indicate a greater general susceptibility than has always been recognized; and their discovery promises to have far-reaching consequences in respect to the means employed to limit the spread or eradicate foci of the disease.

Period of Incubation

Like all other infectious diseases, infantile paralysis does not arise at once after exposure, but only after an intervening lapse of time called the period of incubation. This period is subject to wide limits of fluctuation: in certain instances it has been as short as two days, in others it has been two weeks or possibly even longer. But the usual period does not exceed about eight days.

Period of Infectivity

Probably the period at which the danger of communication is greatest is during the very early and acute stage of the disease. This statement must be made tentatively since it depends on inference, based on general knowledge of infection, rather than on demonstration. Judging from experiments on animals, the virus tends not to persist in the body longer than four or five weeks except in those exceptional instances in which chronic carriage is developed. Hence cases of infantile paralysis which have been kept under supervision for a period of six weeks from the onset of the symptoms may be regarded as practically free of danger.

Protection by Previous Attack

Infantile paralysis is one of the infectious diseases in which insusceptibility is conferred by one attack. The evidence derived from experiments on monkeys is conclusive in showing that an infection which ends in recovery gives protection from a subsequent inoculation. Observations upon human beings have brought out the same

fact, which appears to be generally true, and to include all the forms of infantile paralysis, namely the paralytic, meningeal, or abortive, which all confer immunity.

Basis of the Immunity

The blood of normal persons and monkeys is not capable of destroying or neutralizing the effect of the virus of infantile paralysis. The blood of persons or monkeys who have recovered from the disease is capable of destroying or neutralizing the effect of the virus. The insusceptibility or immunity to subsequent infection, whether occurring in human beings after exposure or monkeys after inoculation, rests on the presence of the destroying substances, the so-called immunity bodies, which arise in the internal organs and are yielded to the blood. So long as these immunity bodies persist in the body, protection is afforded; and their presence has been detected twenty years or even longer after recovery from infantile paralysis. Experiments have shown that the immunity bodies appear in the blood in the course of even the mildest attack of the disease, which fact explains why protection is afforded irrespective of the severity of the case.

Active Immunization

Protection has been afforded monkeys against inoculation with effective quantities of the virus of infantile paralysis by previously subjecting them to inoculation with sub-effective quantities or doses of the virus. By this means and without any evident illness or effect of the protective inoculation, complete immunity has been achieved. But the method is not perfect since in certain instances not only was immunity not obtained, but unexpected paralysis intervened. In the instances in which protection was accomplished, the immunity bodies appeared in the blood.

Passive Protection

By transferring the blood of immune monkeys to normal or untreated ones, they can be rendered insusceptible or immune, and the immunity will endure for a relatively short period during which the passively transferred immunity bodies persist. The accomplishment of passive immunization is somewhat uncertain, and its brief duration renders it useless for purposes of protective immunization.

Serum Treatment

On the other hand, a measure of success has been achieved in the experimental serum treatment of inoculated monkeys. For this purpose blood serum derived either from recovered and protected monkeys or human beings has been employed. The serum is injected into the membranes about the spinal cord, and the virus is inoculated into the brain. The injection of serum must be repeated several times in order to be effective. Use of this method has been made in a few instances in France where the blood serum derived from persons who had recovered from infantile paralysis has been injected into the spinal membranes of persons who have just become paralyzed. The results are said to be promising. Unfortunately, the quantity of the human immune serum is very limited, and no other animals than monkeys seem capable of yielding an immune serum and the monkey is not a practicable animal from which to obtain supplies.

Drug Treatment

The virus of infantile paralysis attacks and attaches itself to the central nervous organs. Hence it is reached not only with difficulty because nature has carefully protected those sensitive organs from injurious materials which may gain access to the blood, but it must be counteracted by substances and in a manner that will not them-

selves injure those sensitive parts. The ideal means to accomplish this purpose is through the employment of an immune serum, since serums are among the least injurious therapeutic agents. The only drug which has shown any useful degree of activity is hexamethylenamin which is itself germicidal, and has the merit of entering the membranes, as well as the substance of the spinal cord and brain in which the virus is deposited. But experiments on monkeys have shown this chemical to be effective only very early in the course of the inoculation and only in a part of the animals treated. Efforts to modify and improve this drug by chemical means have up to the present been only partially successful. The experiments have not yet reached the point where the new drugs are applicable to the treatment of human cases of infantile paralysis.

Practical Deductions and Applications

1. The chief mode of demonstrated conveyance of the virus is through the agency of human beings. Whether still other modes of dissemination exist is unknown. According to our present knowledge, the virus leaves the body in the secretions of the nose and throat and in the discharges from the intestines. The conveyers of the virus include persons ill of infantile paralysis in any of its several forms and irrespective of whether they are paralyzed or not, and such healthy persons who may have become contaminated by attendance on or association with the ill. How numerous the latter class may be is unknown. But all attendants on or associates of the sick are suspect. These healthy carriers rarely themselves fall ill of the disease; they may, however, be the source of infection in others. On the other hand, the fact that infantile paralysis is very rarely communicated in general hospitals to other persons, whether doctors, nurses or patients, indicates that its spread is subject to ready control under restricted and supervised sanitary conditions.

2. The chief means by which the secretions of the nose and throat are disseminated are through the act of kissing, coughing or sneezing. Hence during the prevalence of an epidemic of infantile paralysis, care should be exercised to restrict the distribution as far as possible through these common means. Habits of self-denial, care and cleanliness and consideration for the public welfare can be made to go very far in limiting the dangers from these sources.

Moreover, since the disease attacks by preference young children and infants, in whom the secretions from the nose and mouth are wiped away by mother or nurse, the fingers of these persons readily become contaminated. Through attentions on other children or the preparation of food which may be contaminated, the virus may thus be conveyed from the sick to the healthy. The conditions which obtain in a household in which a mother waits on the sick child and attends the other children are directly contrasted with those existing in a well-ordered hospital: the one is a menace, the other a protection to the community. Moreover, in homes the practise of carrying small children about and comforting them is the rule, through which not only the hands, but other parts of the body and the clothing of parents may become contaminated.

3. Flies also often collect about the nose and mouth of patients ill of infantile paralysis and feed on the secretions, and they even gain access to the discharges from the intestines in homes unprotected by screens. This fact relates to the domestic fly, which, becoming grossly contaminated with the virus, may deposit it on the nose and mouth of healthy persons, or upon food or eating utensils. To what extent the biting stable

fly is to be incriminated as a carrier of infection is doubtful; but we already know enough to wish to exclude from the sick, and hence from menacing the well, all objectionable household insects.

Food exposed to sale may become contaminated by flies or from fingers which have been in contact with secretions containing the virus; hence food should not be exposed in shops and no person in attendance upon a case of infantile paralysis should be permitted to handle food for sale to the general public.

4. Protection to the public can be best secured through the discovery and isolation of those ill of the disease, and the sanitary control of those persons who have associated with the sick and whose business calls them away from home. Both these conditions can be secured without too great interference with the comforts and the rights of individuals.

In the first place where homes are not suited to the care of the ill so that other children in the same or adjacent families are exposed, the parent should consent to removal to hospital in the interest of the sick child itself, as well as in the interest of other children. But this removal or care must include not only the frankly paralyzed cases, but also the other forms of the disease. In the event of doubtful diagnosis, the aid of the laboratory is to be sought since even in the mildest cases changes will be detected in the cerebrospinal fluid removed by lumbar puncture. If the effort is to be made to control the disease by isolation and segregation of the ill, then these means must be made as inclusive as possible. It is obvious that in certain homes isolation can be carried out as effectively as in hospitals.

But what has been said of the small incidence of cases of the disease among the hospital personnel and those with whom they come into contact, indicates the extent to which personal care of the body by adults and responsible people can diminish the menace which those accidentally or unavoidably in contact with the ill are to the community. Care exercised not to scatter the secretions of the nose and throat by spitting, coughing and sneezing, the free use of clean handkerchiefs, cleanliness in habits affecting especially the hands and face, changes of clothes, etc., should all serve to diminish this danger.

In the end, the early detection and isolation of the cases of infantile paralysis in all of its forms, with the attendant control of the households from which they come, will have to be relied upon as the chief measure of staying the progress of the epidemic.

5. The degree of susceptibility of children and other members of the community to infantile paralysis is relatively small and is definitely lower than to such communicable diseases as measles, scarlet fever, and diphtheria. This fact in itself constitutes a measure of control; and while it does not justify the abatement of any practicable means which may be employed to limit and suppress the epidemic, it should tend to prevent a state of over-anxiety and panic from taking hold of the community.

6. A percentage of persons, children particularly, die during the acute stage of the disease. This percentage varies from five in certain severe epidemics to twenty in others. The average death rate of many epidemics has been below 10 per cent. A reported high death rate may not be actual, but only apparent, since in every instance the death will be recorded, while many cases which recover may not be reported at all to the authorities. In the present instance it is too early in the course of the epidemic to calculate the death rate, which may prove to be considerably lower than it now seems to be.

7. Of those who survive, a part make complete recoveries, in which no crippling whatever remains. This number is greater than is usually supposed, because it includes not only the relatively large number of slight or abortive cases, but also a considerable number of cases in which more or less of paralysis was present at one time. The disappearance of the paralysis may be rapid or gradual—may be complete in a few days or may require several weeks or months.

The remainder, and unfortunately not a small number, suffer some degree of permanent crippling. But even in this class, the extent to which recovery from the paralysis may occur is very great. In many instances the residue of paralysis may be so small as not seriously to hamper the life activities of the individual; in others in whom it is greater it may be relieved or minimized by suitable orthopedic treatment. But what it is imperative to keep in mind is that the recovery of paralyzed parts and the restoration of lost muscular power and function is a process which extends over a long period of time—that is, over months and even years. So that even a severely paralyzed child who has made little recovery of function by the time the acute stage of the disease is over, may go on gaining for weeks, months, and even years until in the end he has regained a large part of his losses. Fortunately, only a very small number of the attacked are left severely and helplessly crippled. Lamentable as it is that even one should be so affected, it is nevertheless a reassurance to know that so many recover altogether and so much of what appears to be permanent paralysis disappears in time.

There exists at present no safe method of preventive inoculation or vaccination, and no practicable method of specific treatment. The prevention of the disease must be accomplished through general sanitary means; recovery from the disease is a spontaneous process which can be greatly assisted by proper medical and surgical care. Infantile paralysis is an infectious disease, due to a definite and specific microorganism or virus; recovery is accomplished by a process of immunization which takes place during the acute period of the disease. The tendency of the disease is toward recovery and it is chiefly or only because the paralysis in some instances involves those portions of the brain and spinal cord which control respiration or breathing and the heart's action, that death results.

Finally, it should be added that not since 1907, at which time the great epidemic of infantile paralysis, or poliomyelitis, appeared in this country, has the country or this state or city been free of the disease. Each summer since has seen some degree of accession in the number of the cases; the rapid rise in the number of cases this year probably exceeds that of any previous year. But it must be remembered that in 1908 several thousand cases occurred in the greater city—possibly indeed many cases of and deaths due to the disease were never reported as such. Hence the present experience, severe and serious as it is, is not something new; the disease has been severely epidemic before and was brought under control. The knowledge regarding it now is far greater than it was in 1908; and the forces of the city which are dealing with the epidemic are probably better organized and in more general cooperation than ever before. The outlook, therefore, should not be regarded as discouraging.

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THE BASIS OF INDIVIDUALITY IN ORGANISMS. A DEFENSE OF VITALISM[1]

IN his presidential address before the Zoological Section of the British Association for the Advancement of Science, Professor D'Arcy W. Thompson ('11) said:

> While we keep an open mind on this question of vitalism, or while we lean, as so many of us now do, or even cling with a great yearning, to the belief that something other than the physical forces animates the dust of which we are made, it is rather the business of the philosopher than of the biologist, or of the biologist only when he has served his humble and severe apprenticeship to philosophy, to deal with the ultimate problem. It is the plain bounden duty of the biologist to pursue his course unprejudiced by vitalistic hypotheses, along the road of observation and experiment, according to the accepted discipline of the natural and physical sciences. . . . It is an elementary scientific duty, it is a rule that Kant himself laid down, that we should explain, just as far as we possibly can, all that is capable of such explanation, in the light of the properties of matter and of the forms of energy with which we are already acquainted.

This quotation will serve as a text for, and the keynote of, the remarks I shall make this morning. For to Professor Thompson's thesis I heartily subscribe. And if in what I say any statement seems irreconcilable with his assertions, such inconsistency is unintentional and, as I believe, apparent rather than real. But that all will follow me as sympathetically as I assume you have listened to the remarks I have quoted is more than I venture to hope.

As I interpret the topic under discussion, two main problems are involved:

1. The scientific problem of vitalism and mechanism.
2. The philosophical problem of idealism and materialism.

[1] An address delivered before the American Society of Zoologists and Section F (Zoology) of the American Association for the Advancement of Science at Columbus, Ohio, December 29, 1915, in a symposium upon "The Basis of Individuality in Organisms."

I. THE SCIENTIFIC PROBLEM OF INDIVIDUALITY —VITALISM VS. MECHANISM

The scientific problem of vitalism *vs.* mechanism has recently been formulated by Jennings ('14, p. 17) as follows:

"Is individuality a phenomenon not determined by the perceptual conditions, but requiring to account for it the agency of a non-perceptual agent?" To the discussion of this problem we shall first turn.

The analysis of the concept of individuality—at least human individuality—reveals that individuality presents itself in two aspects, distinguishable in thought if not in reality:

1. The objective or physical aspect of individuality;
2. The subjective or psychical aspect of individuality.

Turning our attention, then, to

1. *The Objective or Physical Aspect of Individuality.*—In this aspect, the organic individual is a persistent, complex, coherent and spatially-distinct whole, consisting of interdependent parts. The organic individual is distinguishable from the inorganic individual by the chemical process of proteid metabolism, growth by the intussusception of new material, and by the process of reproduction. In the higher animals and man integration of the highly differentiated body is effected through the mechanism of a central nervous system and the secretions (hormones) of certain glands. As a physical body the organic individual is subservient to the laws of sequential mechanistic causation, and derives all its energy directly or indirectly from the sun.

2. *The Subjective or Psychical Aspect of Individuality.*—Each organic individual—at least in the case of man—is directly aware of a series of "states" or "moments"

of consciousness, determined directly or indirectly through the agency of the various senses. Within this "wave of consciousness" are presented all of the experiences which together make up the drama of life of the individual. While consciousness may not be defined (except in terms of itself), it may be described.

To other individuals this "inner life" of each individual is non-perceptual, but may —in the case of man—be described through language or other physical expression. To the fact of its non-perceptuality to others. is due the "seeming unreality of the inner life."

All the "data" of science are data of conscious experience. The "experiences" of the individual fall into two chief classes:

(*a*) Those experiences which appear as manifestations of the properties of matter and which may be described or interpreted in terms of matter in motion—spatial phenomena.

(*b*) Those experiences such as emotions which do not have spatial attributes—non-spatial phenomena.

But consciousness—the psychical aspect of the individual—is not merely a string of sequential "moments" of consciousness. Its most essential characteristic is its purposeful unity. There is something which unifies, relates and orders the states of consciousness in each individual. This "something"—the "Ego" or "Will"—is able to dislocate in time the order of sequence of past experiences.

Although mind and body—the physical and psychical—are distinguishable in thought, there is no scientific evidence that they are separate in reality.

The laws of sequential causation apply to mental states just as to physical ones.

Mental processes are among the most reliable phenomena in Nature (Glaser, '12).

The problem of vitalism is: How are we to interpret the behavior of this psycho-physical individual?

Two historical answers have been given to the scientific problem of vitalism—(1) the answer of mechanism; (2) the answer of vitalism.

1. *The Mechanistic Interpretation of Individuality.*—Mechanism is the doctrine that all phenomena—living and lifeless—are manifestations of the properties of matter in motion. According to mechanism, sequential physical causation is universal and involves only those forms of energy recognized by physics and chemistry. Such sequences may be either (*a*) mechanical or reversible, like those of machines; or, (*b*) physical or non-reversible, like the radiation of heat. According to mechanism, all vital sequences conform to one or the other of these two types. Individual behavior is —directly or indirectly—the expression of the energy liberated during the chemical process of metabolism. Mechanism recognizes no alien influx or interference of "souls" or "entelechies" in the endless series of physical sequences.

If we let B represent the body (physical individual), and (w) represent the mechanistic view of will (consciousness) as an epiphenomenon, the mechanistic formula of the individual is $B(w)$.

2. *The Vitalistic Interpretation of Individuality.*—According to vitalism the mechanistic formula is inadequate to nature and to life. In the living body—at least in the case of man—sequential causation involves another factor or agency than those recognized by chemists and physicists. This non-physical (non-spatial) "vitalistic" agency modifies the behavior of the living organism so that, from a knowledge of the physical conditions only, "it would be impossible to predict what will happen under any given set of physical conditions." According to vitalism, the will or

other vitalistic agency "so interacts with physical conditions as to give a physical result that is diverse from the result that would be produced under the same antecedent conditions without consciousness" (Jennings).

According to vitalism the formula for the organic individual is either (*a*) the dualistic formula $W + B$ (W representing the will or vitalistic agency, and B the body or physical aspect of individuality); or, (*b*) the idealistic formula $W(b)$ (W representing the will or vitalistic agency, and (b) the phenomenal body).

The divergence between the mechanistic and the vitalistic interpretation of individuality is, therefore, very great, constituting in fact "the greatest schism in human thought." "The vitalist sees in individuality—personality or the self—a coordinating center and synthetic activity contrasted with all other agencies in nature—a real creative power. While the mechanist sees only what he sees in any other receptive object, a center where many forces cross, checking, intensifying, neutralizing or transforming one another without loss or addition" (Palmer, '11).

Which of these two interpretations are we to accept? Are the two views wholly irreconcilable? Is the problem of individuality, after all, an insoluble one?

Opinions differ. The literature is voluminous, for this is the problem of the ages. Wholly unprejudiced discussion is rare. Among scientific men the cause of vitalism has suffered because of its association historically with theological dualism, while on the other hand many vitalists have opposed mechanism upon the mistaken belief that mechanism is identical with—or demands the postulate of—philosophical materialism.

Among the divergent views expressed, a few may be mentioned which are indicative of the trend of present opinion concerning the problem of individuality—the problem of vitalism and mechanism.

Professor L. J. Henderson finds that the discussion of the vitalistic problem has led to the following dilemma:

Assertion 1.—Common sense—as represented by those who make a study of the movements of physical bodies—leads to the conclusion that all physical events are subject to the laws of physical causation.

Assertion 2.—Common sense—as represented by those who make a study of the behavior of men in history—leads to the conclusion that some physical events are not subject to the laws of physical causation alone, but that will or caprice has affected the course of historical events.

Now since both assertions appear to be equally valid in common sense experience, and as both opinions can not be true at the same time, and as there seems to be no immediate prospect of their reconciliation, Professor Henderson turns away his attention to more promising lines of investigation.

William MacDougall ('11) discovers the same dilemma. On the ground, however, that the issues involved are too important to admit of neutrality, he casts in his lot with the vitalists. His book on "Body and Mind" is a strong defense of the vitalistic thesis. Other recent valuable contributions to the formulation and elucidation of the vitalistic problem have been made by Ward ('03), Driesch ('14), Bütschli ('01), Palmer ('11), Bergson ('11), Jennings ('14), Lovejoy ('09), Spaulding ('09), Sumner ('10), Woodruff ('11), Ritter ('11), Glaser ('12), R. McDougall ('13), R. S. Lillie ('14), A. J. Balfour ('79), Stout ('05), Lloyd Morgan ('05), Paulsen ('95), Höffding ('05), Haldane ('08), Ladd ('09), Bosanquet ('12), Strong ('03), Conklin ('15), Loeb ('11), James ('07).

Jennings ('14, p. 20), taking up the problem as a scientific problem by the method of radically experimental analysis, reaches the following conclusion:

The phenomena of life require nowhere the differential action of a non-physical agent. Their occurrence is bound up throughout with that of physical and material phenomena. Diversities in them are determined by antecedent physical and material diversities. They show, therefore, the same type of relations to each other, to physical conditions, and to matter, as do the phenomena called physical. But they include phenomena not found in the non-living, and therefore to be known only through study of the living. Such is conscious individuality, the highest manifestation from the interwoven tissue that makes up the experienced universe.

That is to say, Jennings comes to the conclusion that the problem of vitalism has no experimental meaning. With this opinion presumably the majority of biologists will agree.

Is this, then, the final answer of science (physical science) to the problem of the ages? Is the case of Vitalism vs. Mechanism closed and the verdict rendered in behalf of the defendant? Will the vitalist accept the verdict? We may anticipate that he will not, if we are to judge on the basis of past experience. In the past when verdicts have been rendered against him—as in the Vital Spirits Case, the Urea Case, the Vital Force Case, etc., he has always shifted his ground, and although defeated in every trial, he has always been able to secure a rehearing of his case in the same court—the court of physical science. Will he do so now? I am of the opinion that he will.

But on what grounds can he make an appeal? He can scarcely convince a scientific jury that his case has not been heard in all fairness and impartiality upon the basis of the premises made. He may not fairly claim that the experimental and analytical logical methods have been inadequate or inconclusive. So far as I can see, his only chance of securing a rehearing at the court of science or in the higher court of philosophy (as suggested by Professor Thompson, '11) would be to demonstrate that the fundamental postulates upon which his case has been previously tried have been in error, and that the conclusions reached have been based on false premises. On this ground there would seem to be sufficient justification for taking his case to the higher court of philosophy, which has jurisdiction over matters relating to fundamental postulates.

If, then, the vitalist can show that his case has been prejudiced by the philosophical assumptions made in previous trials, if it must be admitted that it makes a difference to the case of the vitalist whether it be based upon materialistic, or dualistic or idealistic postulates, and if it can be shown that the basis upon which the case has been tried has not been the only possible basis upon which it might be tried and that, in fact, it has been tried upon a wholly false basis, then the vitalist is justified in demanding a rehearing in the higher court of philosophy, which has jurisdiction over such cases. Such considerations are, I infer, the reasons for the selection of this morning's topic. And if the outcome of the discussion be the decision that the case of vitalism has been prejudiced in the past by the false premises made by the attorneys who have handled the case in the court of science, then in all fairness the vitalist should be granted the rehearing he now demands.

It has been frequently assumed in the discussion of vitalism by scientific writers that the formula of mechanism is adequate to experience. This, for example, appears to be the assumption which underlies the argument of Jennings ('14). Shall this assumption pass unchallenged? Certainly

not by the vitalist. He has challenged it again and again, holding that it is not justified in experience. This is the argument of the vitalist in brief: He asserts:

The case of vitalism is not one to be tried in the court of physical science, for it does not come within the jurisdiction of that court, since the mechanistic formula is inadequate to life. For

Physical science treats of only a part of human experience—viz., that part of human experience having spatial attributes, or which may be interpreted in terms of matter in motion.

But human experience includes phenomena without spatial attributes—phenomena which may not be interpreted in terms of matter in motion. This is recognized by the division of the sciences into the physical sciences, which deal with those phenomena having spatial attributes (or which are the manifestations of the attributes of matter in motion); and the mental sciences—psychology and philosophy and ethics—which deal more especially with non-spatial experience. But individuality (human personality) includes both classes of phenomena. The court of physical science, therefore, in trying the case of individuality is dealing with one which does not strictly come within its jurisdiction. Hence, vitalism—the case of personality—now appeals to the higher court of philosophy which tries cases relating to the fundamental postulates of both mental and physical sciences.

But is the vitalist justified in his assertion that physical science—mechanism—is inadequate to experience? Here there is decided difference of opinion. Dr. Jennings supports the "mechanistic dogma" of the universal applicability of mechanistic interpretation. For he says ('14, pp. 6–5) that mechanism is a "purely descriptive account of what is found to hold in experience." "There is no ground, theoretical or practical, for limiting scientific treatment to diversities of any particular kind (as diversities of motion)," that, in other words, the field of physical science includes the entire field of human experience. "Mechanism," therefore, is adequate to nature and to individuality. Consequently, if this position be taken, there would appear to be no reason for continuing the case of vitalism further.

I am unable to discover that any considerable number of psychologists accept Dr. Jennings's assumption. On the contrary, the great majority seem to agree with Professor Ladd when he says ('09, p. 884):

> Thinking and the cognitive judgment can never be explained—and, indeed, the facts can not even be stated—in terms of either neururgics or the mechanism of presentations.

In other words, there is doubt that psychologists would accept the assumption of Jennings of the adequacy of mechanism to experience. For the same reason, his further assumption—underlying his whole argument—that "every diversity in conscious states is accompanied by a diversity in physical conditions" may be challenged as far transcending our present knowledge. The vitalist may call attention to the fact that Dr. Jennings assumes as the basis of his argument the very point under discussion—the question in litigation—viz., the adequacy of the mechanistic formula.

But I am of the opinion that the vitalist has the best of reasons for appealing his case to a higher court on the ground that the basic philosophical assumptions upon which his case has been argued have prejudiced the case against him and have been philosophically unsound. For all who have discussed the case of vitalism in relation to individuality (personality) have made implicitly or explicitly philosophical assumptions. Indeed, the problem of the psycho-physical individual can not be dis-

cussed otherwise. W. MacDougall ('11) argues the case for vitalism on the basis of philosophical dualism. The dualistic assumption appears to underlie the "common sense" argument advanced by Professor Henderson. James Ward ('03) advocates the case of vitalism on the basis of a critical idealism (spiritualism).

That Jennings ('14, p. 18) accepts the postulate of materialism is clear from his assertion that "when the set of phenomena we call matter reaches a certain complexity, it gives rise to this particular manifestation that we call personality." In other words, unconscious matter in the course of evolution produced consciousness. Before this stage of material evolution consciousness did not exist—there was no consciousness. Matter exists before mind, but later gives rise to consciousness as a quality of an underlying substance. The real thing then is matter which indeed once existed independently of any consciousness at all. Whether there were any consciousness or not, matter would still persist. The real organic individual is the physical individual, and all its qualities—psychical and other—are manifestations of this basic material body. This tacit assumption was presumably behind the declination of Jennings ('14) to accept the two classes of conscious experience mentioned above.

Is the materialistic assumption nonvalid? Does its postulation by Jennings prejudice the case of vitalism? Is the case of vitalism "ruled out of court" and completely subverted if the materialistic postulate is admitted? Unquestionably it is. For materialism (philosophical, not scientific) is the one philosophy with which vitalism is wholly irreconcilable. To assume it, therefore, is to deny vitalism (neo-vitalism). The case doesn't have to be tried at all. But the whole contest which has been waged by vitalism has been against materialism. In opposing mechanism the vitalist has been "barking up the wrong tree." His mistake has been due to the inexcusable identification of mechanism with philosophical materialism. Vitalism has no real issue with mechanism—not at least with mechanism as a scientific method of interpretation of spatialized phenomena. But with philosophical materialism as a postulate of science the vitalist may for the best of reasons take issue. Therefore, as Paul appealed to Cæsar and to the higher court of Rome, the vitalist may with justice ask for a continuation of his case in the higher court of philosophy.

What then is the philosophical standing of the materialistic postulate? What really is basic to individuality (human personality)? Of what are we more certain—of an external world independent of consciousness and consisting of atoms or electrons in motion, or of a world of ideas, of purposes and of emotions? We therefore are compelled to consider the philosophical problem of reality and the case of vitalism becomes in the higher court of philosophy the Case of Idealism (or Dualism) *vs.* Materialism. To this, the second point of the topic under discussion, we may now turn our attention.

II. THE PHILOSOPHICAL PROBLEM OF INDIVIDUALITY—IDEALISM (OR DUALISM) VS. MATERIALISM

The problem which is now before us is the central problem of philosophy—the problem of reality. Is the materialist correct in holding that the organic individual (human personality) is in reality an aggregate of atoms or electrons which might exist independently of consciousness? Is, therefore, the formula for the individual $B(w)$?

Is the dualistic philosopher correct in asserting that the individual consists of two realities—body and mind—which are not only distinguishable in thought, but also separate in reality, although united tem-

porarily in human individuality? Is, therefore, the formula for the individual $B + W$?

Or is the idealist correct in maintaining that the individual is in reality spiritual—a Will or "Ego" with physical manifestations? Is the body of the organism an ideal (though none the less real) body—a mechanism through the agency of which the will or Ego operates? Is, therefore, the formula of individuality $W(b)$?

Upon the answer given to these questions by the philosopher will depend the future standing of vitalism in science.

The considerations which have led most philosophers and many men eminent in science to repudiate the materialistic assumption and to conclude that in ultimate analysis and in reality our world and the individual is spiritual are in brief as follows:

In the first place, the data of science are phenomena in consciousness. For anything to be outside of consciousness, therefore, is to be unknown, and hence outside of the field of science which deals with the known. To postulate an external world of atoms and electrons independent of—or outside of—consciousness is to postulate an unknowable world—a metaphysical world. It is a wholly erroneous notion that this conclusion of philosophy involves the denial of an external world—the "permanent possibility of sensation." There is indeed—to the idealist not less than to the realist—an external world which is the cause of our ideas. But this external world of ours must be a world of ideas—that is, if it is like our ideas as we believe it is. But if the objects in this external world are like our ideas, then they must be ideas. Therefore, "either the real external world is a world of ideas—an outer world of mind which each of us may in a measure comprehend through experience, or—so far as it is external and real—it is wholly unknowable" (Royce, '92). "It was Berkeley," says Lloyd Morgan ('05), "who knocked the bottom out of materialism as a philosophy so that no amount of tinkering can make it again hold water." Materialism, therefore, as a philosophy, has long been in disrepute among philosophers. It is, therefore, almost incomprehensible why an outworn and discarded philosophy should be made the basis of a scientific discussion of the problem of individuality. Are we to assume that "one assumption is just as good as another" and that it is impossible to distinguish between true and false assumptions? Does it not matter to us whether our basic assumptions are philosophically sound or not? Are the conclusions reached by modern philosophy of no concern to the biologist in the discussion of the problem of individuality?

The acceptance of the materialistic postulate by scientific men notwithstanding its philosophical disrepute appears to be due in part to the confusion of philosophical with scientific materialism, and in part to the strong prejudice against philosophical views owing to the excesses of philosophers during the romantic period. The combination of this prejudice with that against philosophy as the "handmaid" of religion makes it to-day almost impossible for philosophical arguments to receive a fair hearing in the court of physical science. How in the history of human thought the mechanistic interpretation of the phenomena of the external world became gradually transformed into a philosophy of life may best be understood by a brief statement of its genesis in the thought of the individual.

The untrained person considers the world to be just about what his senses tell him it is. Later, however, he learns to distinguish between an internal reality and an "external" reality and he finally comes to ask, "How much can I know of external reality?" He soon learns that all he can know

of the "external" world must be acquired through the senses, *i. e.*, through the physiological-psychological process. This process involves three steps: (1) The stimulus (the object in the external world); (2) The nerve disturbance (caused by the stimulus); (3) The sensation or sense impression (the result of the nerve disturbance). Through the discoveries of the chemist and the physicist he learns that all of the phenomena of the external world may be reduced to or expressed in terms of atoms or electrons in motion, rapidly in gases, less so in liquids and still less so in solids; that all chemical change involves a rearrangement of atoms, and finally that all forms of energy depend on the rapid movement of atoms. Moreover, the physiologist assures him that these assertions hold true for the living as well as for the lifeless. Thus the physical (external) universe appears to be a universe of atoms or electrons in motion.

Up to this point in his thinking our hypothetical friend has been standing on perfectly sound ice. With his conclusion there is not the slightest reason to disagree. This —the mechanistic interpretation of the physical universe—is the accepted interpretation of our generation. Its validity as a scientific hypothesis stands unchallenged. There is no reason whatever to believe that in principle it will ever be overthrown. The mechanist gets on very thin and very treacherous ice (where the philosopher is unable to follow him) when he infers that when electrons come together in certain propositions and under certain conditions consciousness would be the result. Thus he might reach the conclusion of the materialist that whether there were any consciousness at all, the dance of atoms and the material universe would go on just the same. The universe, then, he concludes, is in reality a universe of atoms and electrons independent of consciousness. Some such process of reasoning as this appears to be the usual method of the transformation of the mechanistic thinker into a materialistic philosopher. The considerations which appear to invalidate his conclusion have already been stated above.

The disproof of materialism (as a philosophy—not as a working scientific hypothesis) is at the same time the argument adduced in support of philosophical idealism (spiritualism), the status of which is so unquestioned that it has become the dominant philosophy of the twentieth century. Many scientific investigators impressed by its logical soundness have adopted it as the basis of their thought and of their interpretation of nature and of life.

That the world of science is withal a world of ideas has been appreciated by scientific thinkers scarcely less than by philosophers. "Our one certainty is the existence of the mental world," writes Huxley. "Ego is the only reality and everything else is only Ego's idea," says Charles Sedgwick Minot. "The sole reality that we are able to discover in the world is mind," says Verworn. "Our world is after all a world of individual consciousness and ideas," says Crampton. "The field of science is essentially the contents of the mind," says Karl Pearson. "The world of knowledge is of such stuff as ideas are made of," writes Josiah Royce.

Thus the basis of modern critical idealism is so sound that its position has come to be regarded as impregnable, and the arguments now used against it are not directed at its foundations, but at certain supposed logical consequences of its acceptance. Many of the arguments raised against critical idealism are based on misunderstanding. One of these is the erroneous inference that idealism is subversive of a mechanistic interpretation of the physical universe. To hear some of the arguments used against it

one would think that neither philosophy nor theology had advanced during the development of human thought. Idealism is not a doctrine of those who "wish to lay the intellect to rest on a pillow of obscure ideas," nor is it an attempt to undermine mechanistic hypotheses. Many of the objections are made by those who confuse modern critical idealism with solipsism or subjective idealism. The limits of this paper do not admit the presentation of these objections and their rebuttal. I search in vain, however, for a real, valid, scientific objection to the postulate of modern critical idealism. That it is the dominant philosophy of our generation has already been asserted.

I shall not attempt to discuss the dualistic postulate, since it has little standing among philosophers and none at all among men of science—except upon such illogical grounds as even scientific men are capable. The dualistic hypothesis, therefore, doesn't interest us. But if one were compelled to choose between the postulate of dualism and that of materialism the adoption of the former would appear to be far more rational.

It is well recognized that epiphenomenalism is but thinly disguised materialism and the arguments against the latter apply equally against the former. Of epiphenomenalism Minot ('02, p. 3) says:

An epiphenomenon is something superimposed upon the actual phenomena having no causal relation to the further development of the process. There is no idea at all underneath the epiphenomenon hypothesis of consciousness. The hypothesis is simply an empty phrase, a subterfuge—which amounts to this—we can explain consciousness very easily by merely assuming that it does not require to be explained at all.

Says W. McDougall ('11, p. 150):

Epiphenomenalism, though it may perhaps be consistent with the law of the conservation of energy, offends against a law that has a much stronger claim to universality, namely the law of causation itself; for it assumes that a physical process, say a molecular movement of the brain, causes a sensation, but does so without the cause passing over in any degree into the effect, without the cause spending itself in any degree in the production of the effect, namely, the sensation.

Consequently, in our discussion of the problem of individuality, we are compelled, I believe, to make our choice between philosophical materialism and idealism (spiritualism), that is to say, between mind and matter (independent of mind) as the basis of individuality. Our choice is to be made between a postulate which is philosophically disreputable and one which has been accepted by the great philosophers of recent times from Berkeley and Kant to Emerson, Royce and James; between the assumption of a wholly unknowable and metaphysical world and the indisputable assumption that our one surest reality is consciousness; between the Haeckelian riddle and the assumption that our world has moral and spiritual meaning; between a world in which the words and gestures of every individual "would have been just what they have been, the same empires would have risen and fallen, the same masterpieces of music and poetry would have been produced, the same indications of friendship and affection would have been given in the absence of consciousness" (C. Lloyd Morgan, '05), and the "common sense" view of the historian that human motives and purposes have affected the course of human events; between a fatalistic world of illusion, on the one hand, and a world in which choices are real and ideals count; between an assumption which renders untenable the great human ideas of God, freedom and immortality and one which gives these unquestionable validity.

That modern philosophy has repudiated the materialistic postulate is not surprising in the light of the considerations presented above. Its adoption by biologists as the

basis of their interpretation of personality and of life is incomprehensible unless it be assumed that biologists are strongly prejudiced against the idealistic philosophy through misunderstanding. But, since the materialistic postulate is not only philosophically unsound and wholly unnecessary for any ends which the mechanist has in view, and since it is metaphysical, unscientific and irrational—wholly inconsistent with the lives of those who make it, as Conklin ('15) has said—biologists must reject it and accept the idealistic assumption as modern philosophy has done. We need to bring back our scientific postulates to the touchstone of fact. Our biological premises have been too narrow. We live in a larger scheme of things than mechanism has been able to discover. There is more in life than is dreamed of in the materialistic philosophy.

> The world of space and time, of physical cause and effect, matter and finite mind is but a very subordinate part of reality (Royce).

The way out of the blind alley into which materialism has led us is, as D. G. Brinton has said, "not by the assumption of an entity apart from attributes; but by the indisputable truth that the laws of mechanics and motion themselves are in final analysis nothing else but laws of thought of the reasoning mind, and derive their first and only warrant from the higher reality of that mind."

In the light of such considerations and in view of the fact that the materialistic postulate has usually been the basis of the biological discussion of the problem of individuality, and in view of the fact that upon the materialistic assumption the vitalistic interpretation of life is wholly excluded and therefore has no experimental meaning, the vitalist seems not unreasonable in his demand for a rehearing of his case upon an idealistic basis. For, upon this basis, the possibility of a vitalistic interpretation is not excluded as it actually is upon the materialistic basis. Upon the idealistic premise the possibility is open that not all of individuality (personality) is spatially expressed, that is to say, mechanized. In other words, upon this assumption the contention of the vitalist may be valid—viz., that from a knowledge of the physical conditions alone "it would be impossible to predict what will happen under any given set of physical conditions." The case of the vitalist depends wholly upon the overthrow of philosophical materialism. The problem of vitalism has thus become a philosophical one.

Many of the arguments used by vitalists do not appeal to the writer as intrinsically sound. I fully agree with R. S. Lillie ('14) and O. Glaser ('12) that the argument of the insufficiency of mechanism to "explain" everything has been much overworked. And yet there are a few considerations of this sort which seem to me to have some weight. Of these I will mention only two. The first is the difficulty of explaining the synthetic activity of the conscious mind on the basis of brain structure. One of the greatest weaknesses of mechanism in the field of physiological psychology is the lack of appreciation of the synthetic and correlating activity of human consciousness (will).

The other difficulty relates to the phylogenesis of the rational human individual. Is it possible for us to believe that a chaos has become a cosmos without the effective cooperation of a directive intelligence or will? Is it possible to believe on rational grounds that a material universe devoid of mind has produced a mind capable of judging mechanism? Says J. J. Putnam:

> If this were true it would seem possible for a man to lift himself by his boot-straps. But if it be impossible for mechanism (unguided by in-

telligence) to produce the mind of a person capable of judging mechanism, it is clear that mechanism has not been the only principle at work in the evolutionary process.

If Dr. Putnam's contention is sound, it becomes possible to understand the point of view of the modern theologian when he says:

Never yet has something come out of nothing. Never yet has order arisen out of confusion or light out of darkness as a result of anything other than personality. Force, law, life and achievement carry the mind irresistibly to the supreme will, to the supreme life, to the personality of God. A universe teeming with mind, fired within and stamped without with intelligence is the attestation of the living God. God is the meaning of the universe (Gordon, '10).

The acceptance of the idealistic postulate and of the point of view of the neo-vitalist make it possible to understand Dr. Gordon when he says further:

Behind all human achievement we see the creative spirit at work. Back of all achievement in literature we see the personality of Homer and Æschylus, Dante, Goethe and Shakespeare. Behind the achievements of the race in art we see the personality of Praxiteles, Raphael and Michael Angelo. For the entire high achievement of the race there is no explanation but the creative spirit of human personality. In our contemplation of nature and in our attempt to comprehend it we need to carry with us the sense of creation. The universe is the supreme achievement. Behind this achievement is the infinite soul and as our human world is a living and expanding achievement, we must conclude that within it is the creative spirit of God.

That scientific men occasionally catch a glimpse of the theological viewpoint seems borne out by the following quotations:

There is a wider teleology which is not touched by the doctrine of evolution, but is actually based upon the fundamental proposition of evolution (Huxley).

We are beginning to see the ascent of the Ideal of evolution. Thus biological science must indeed become the handmaid of religion (Thomson and Geddes).

Supposing that in youth we had been impregnated with the notion of the poet Goethe, instead of the notion of the poet Young, looking at matter not as brute matter, but as the living garment of God, is it not probable that our repugnance to the idea of the primeval union between spirit and matter might be considerably abated? (Tyndall).

I see everywhere the inevitable expression of the Infinite in the world (Louis Pasteur).

In whatever direction we pursue our researches, whether in time or space, we discover everywhere the clear proofs of a Creative Intelligence (Sir Charles Lyell).

We are unmistakably shown through nature that she depends upon one ever-acting Creator and Ruler (Lord Kelvin).

I can not imagine the possibility of any one with ordinary intelligence entertaining the least doubt of the existence of a God (William Crookes).

Matter and energy have an original property, assuredly not by chance, which organizes the universe in space and time. . . . If life has originated by an evolutionary process from dead matter, that is surely the crowning and most wonderful instance of teleology in the universe (L. J. Henderson).

If then for the reasons advanced we are to accept the idealistic postulate as the basis of our discussion of individuality, what will be the effect upon the mechanistic interpretation? How wide is the sphere of the mechanist? Just as wide as he used to think before he converted a method of investigation into a complete philosophy and interpretation of life. Most of our lives are mechanistic as we have always believed them to be. A large part of that which is not mechanistic is deterministic. For we are bound by heredity, hormones and habit.

Such limitation—such determinism—is the essential condition, as Palmer ('11) has well said, of that little measure of vitalistic freedom which we actually enjoy. The laws of determinism rule our lives more than the vitalist has been willing to believe. But we are free to choose between two alternative lines of necessity and to that extent at least our fates are in our own hands.

The study of animal behavior justifies the inference that consciousness is effective in them as in man. But to a far greater degree are their lives mechanized. Those of plants appear to be wholly so, whatever they may once have been.

I have made this plea for a rehearing of the case of the vitalist, knowing full well that his is not a popular cause among my scientific colleagues. The reasons why I have done so have been presented. No one realizes more than I the liability of error involved, for I am far from familiar fields of investigation. If I am in error, past experience has taught me that the error will soon be discovered and pointed out by those with whom I differ, and the truth which we all seek will be advanced.

But by no means should men of science play the part of the theologians of the fifties. The spirit of science is not dogmatic. And yet extremes meet and sometimes the spirit of the twentieth-century scientist matches that of the theological dogmatist of the nineteenth. For when Minot ('02) maintained the thesis that consciousness must have been a factor in evolution his paper aroused such bitter opposition that one scientific colleague, who by his prejudices was wholly incapable of appreciating the fundamental strength of Minot's position, had his copy of SCIENCE bound mutilated by leaving out the number containing Dr. Minot's address. He did this on the ground that as a friend of Dr. Minot's he did not wish to perpetuate a paper which would undermine Dr. Minot's reputation as a scientific man.

The objectionable thesis of Minot's was as follows:

It seems to me inconceivable that the evolution of animals should have taken place as it actually has taken place unless consciousness is a real factor and dominant. Accordingly I hold that it actually affects the vital processes. There is, in my judgment, no possibility of avoiding the conclusion that consciousness stands in immediate causal relations with physiological processes. To say this is to abide by the facts, as at present known to us, and with the facts our conceptions must be made to accord.

In justice to the zoologist who did what he could to obliterate all traces of Dr. Minot's paper, it is only fair to say that science has every reason on the basis of experience to regard such "vitalistic" views as "dangerous" from the standpoint of mechanism, because of the constant temptation to pass in explanation over into the psychological field—in other words, to revert to primitive modes of explanation. Therefore, to the person under discussion Dr. Minot may have seemed indeed a traitor to science.

But this is, I am sure, a most exceptional case, and quite anachronous. The spirit of the scientist is not the intolerant spirit of the partisan. Every biologist may be expected to treat the cause of the vitalist as if it were his own cause and grant him the rehearing in the court of philosophy which he now demands. In the discussion of this problem as believers in the scientific method it is our duty to set forth "that calm, fair-minded, tolerant spirit" which has characterized the thought of scientific men in the past. This—the scientific—spirit means, as President Vincent has said:

an attitude of open-mindedness towards all truth; a determination to get all the essential facts before forming a judgment; a willingness to abandon a position when it is no longer intellectually tenable; a tolerance of the opinions of others which are to be accounted for rather than derided or denounced. This spirit is free from acrimony, blind partizanship and prejudice—the spirit which seeks the truth which makes men free.

If, then, the question of vitalism is to be discussed at all in our classrooms—I know of none where this interminable problem is not mentioned—and, if because of conscience's sake we are unable to accept the postulate of idealism, we may nevertheless

give the question fair, impartial and scientific treatment. Such treatment, I am compelled to believe, can not be given without full consideration of the basic principles upon which the discussion has been based. Adequate treatment it can not receive upon the materialistic assumption only. For, as has been shown above, the adoption of this postulate begs the whole question under discussion and precludes the possibility of a vitalistic interpretation of individuality. Therefore, if we must adopt this postulate for ourselves, we ought at least to present the problem as viewed from the standpoint of idealism which clearly admits of the possibility of the vitalistic interpretation, and give our reasons for the rejection of the idealistic assumption. Moreover, failure to set forth the implications which grow out of the acceptance of materialism or idealism would appear to mean the omission of considerations of great importance bearing on the question. But above all let us rid our minds of the wholly erroneous notion that the cause of mechanism demands the postulate of philosophical materialism; and, in case we are vitalists, let us free ourselves for the equally fallacious belief that the mechanistic interpretation of the physical aspect of individuality is irreconcilable with the vitalistic interpretation of *life as a whole*. Like the Darwinian and Lamarckian hypotheses the mechanistic and vitalistic hypotheses are complementary and not irreconcilable interpretations of individuality.

The general purport of this paper, therefore, is well expressed in the words of Professor H. W. Rand ('12, p. 850):

> Science will never solve its problems—at most, it will never do more than think it has solved them —unless it constantly realizes its own limitations and unless it frequently assures itself of the security of its foundations. Now, perhaps more than at any other time, the natural scientist stands in need of help which may well come from the philosopher. Is it not timely to raise the question as to the validity of the assumptions upon which science rests and the integrity of the methods by which we attempt to progress?

Says Rogers ('09):

> It is no unusual thing for human reason to complete its speculative edifice in such haste that it forgets to look to the stability of the foundation.

SUMMARY

A. *The Scientific Problem of Individuality Vitalism vs. Mechanism.*—As formulated by Jennings ('14, p. 17) the problem reads:

> Is individuality a phenomenon not determined by the perceptual conditions, but requiring to account for it the agency of a non-perceptual agent?

There are two historical answers:

1. *The Thesis of Vitalism.*—That "individuality is a phenomenon not determined by the perceptual conditions only."

2. *The Thesis of Mechanism.*—That "individuality is a phenomenon determined by the perceptual conditions only."

1. The *Argument of Vitalism* is based on the assumption that either:

(*a*) The organic individual is in reality monistic, spiritual, a "Will" of "Ego" having material (bodily) manifestations, integrated and individualized not only by a central nervous system and by hormones, but (in the case of human individuality) by a "Will," also. "Will" is the unique characteristic of the individual (personality);

The formula for the individual is: $W(b)$; or, as some vitalists assume,

(*b*) The individual is in reality dualistic, a united will and body.

The dualistic formula for the individual is: $W + B$. The vitalist concludes that individuality (personality) is a phenomenon not determined by the perceptual conditions alone, but requiring to account for it the agency of a non-perceptual agent.

2. The *Argument of Mechanism* is based upon the assumption that:

The organic individual is in reality monistic and material—a body with epiphenomenal mental manifestations. Unity is effected by means of a central nervous system and hormones uninfluenced by a "Will."

The formula for the individual is $B(w)$. The mechanist concludes that individuality (personality) is a phenomenon determined by the perceptual conditions alone. Now, since obviously the conclusion of vitalist and mechanist is not logically deduced, but simply restates the fundamental assumption made, and since the conclusion, therefore, is true only if the assumption is true, and, since the truth of the assumption is a philosophical problem.

The Case of Vitalism *vs.* Mechanism must now be carried to the higher court of philosophy, which has jurisdiction over such cases.

We are therefore compelled to take up—

B. *The Philosophical Problem of Individuality—Idealism (Spiritualism) vs. Materialism.*—What in reality is the basis of individuality in organisms? Is the individual a material body of various properties, and nothing more? Is the basic principle of life spiritual, or material, in reality?

1. The basic assumption of mechanism (materialism) is, that—The individual (human personality) is in reality monistic and material, a body with epiphenomenal mental manifestations, and that individuality is expressed by the formula $B(w)$. Now, since this assumption is found upon analysis by philosophers to be unscientific (unknowable), useless (to the mechanist as well as to others), unnecessary (on logical grounds) and metaphysical, and since it states or interprets the known (*i. e.*, experience) in terms of the unknown and knowable (real substance, independent of consciousness), this materialistic assumption is rejected by modern philosophers. Consequently, if the opinion of experts is to be respected, and if, therefore, we must regard the materialistic assumption as false, then we are compelled to reject the conclusion of the mechanists that an interpretation of individuality (personality) in mechanistic terms alone is adequate to experience. For false premises mean false conclusions.

The acceptance of the idealistic (spiritualistic) assumption by modern philosophers compels us to accept it.

It seems necessary, therefore, to conclude that the vitalist is correct in asserting that not all of personality is spatially expressed. In other words,

Individuality (personality) is a phenomenon not determined by the perceptual conditions only, but requiring to account for it the agency of a nonperceptual agent.

This agent is the "Ego" or "Will." The formula of individuality therefore, is: $W(b)$, and the vitalistic theory "ist noch nicht aus dem Welt geschafft."

And, unless by caprice or prejudice we refuse to trust the opinion of experts and adopt a discredited philosophy as the foundation of our thought, vitalism will continue to be our interpretation of individuality in organisms, although *not, of course, in the mechanistic aspects of individuality.*

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GUSTAV SCHWALBE

THE death is announced of Professor Doctor Gustav Schwalbe, one of the most distinguished anatomists of Germany, who, established in recent years his leadership in the subject of human anatomy through his broad and profound knowledge of comparative anatomy. His analysis of the human remains of the Lower Paleolithic, beginning with the type Neanderthal skull, resulted in the recognition of *Homo neanderthalensis* as a distinct species of the human race. This has been followed by many other penetrating studies from which an entirely new system of cranial measurements has been deduced, namely, an internal system which takes account of the proportions of the brain in place of the external system of Brocca and the older anatomists based on the superficies of the skull. Following the lamented death of Eberhard Fraas, the paleontologist, the loss of Schwalbe will be severely felt in the University of Strassburg. All those who enjoyed the pleasure of the acquaintance of this distinguished anatomist and who recall his genial and modest personality will deeply lament his death.

HENRY FAIRFIELD OSBORN

THE RURAL ROADSIDES IN NEW YORK STATE

BY investigations just completed by the New York State College of Forestry at Syracuse, it has been found that nine tenths of the roadsides in the rural districts of New York state are entirely void of shade trees. When this is considered along with the fact that last year New York state paid out of the state treasury about $30,000,000 for the construction and maintenance of roadbeds, it shows that the state is not yet awake to the great need and the great possibilities in rural roadside improvement.

The preliminary survey which has just been made by H. R. Francis in charge of the landscape extension work of the College of Forestry, covered nearly 3,000 miles of the main lines of highways passing through such important points as Rochester, Buffalo, Jamestown, Olean, Hornell, Corning, Ithaca, Cortland, Elmira, Binghamton, Oneonta, Kingston, Hudson, Albany, Schenectady, Glens Falls, Lake Placid, Malone, Potsdam, Watertown, Utica, Rome and Syracuse.

During the survey studies were made of such important features in rural roadside improvement and beautification as good and bad varieties of trees found along the highways, views and vistas obtained from the highways, the effects of the shade trees on crops in adjacent fields, the possibilities of the covering of barren embankments and the planting of some desirable sort of vegetation where overhead wires are in large numbers. One of the principal features studied was the condition of the roadbed as affected by the presence or absence of shade trees.

A detailed study of the main state highway east and west between Albany and Buffalo will be made immediately by the State College of Forestry. The observations which have already been made in all sections of the state together with the information obtained by the detailed study will be used as a basis for an educational publication to be issued by the college and distributed very widely to organizations in the state, such as the automobile clubs, women's clubs, commercial associations, granges, farm bureaus and the State Forestry Association and other individuals interested in this development.

This is the first comprehensive study to be made of the landscape treatment of the rural roadsides in the state and the college predicts a wider appreciation of the possibilities and the necessity for the planting and preservation of forest trees along the rural roadsides. Few people in the state will be able to visit the wonderful national parks of the west, but an increasing number of people will own automobiles and use the highways of the state. Many if not all of these highways may easily become state park ways of beautiful trees and

shrubs. Trees grow like weeds under the climatic conditions existent in New York and with varied scenery of intense interest the highways of the state will eventually become as beautiful as those of any other state in the union.

THE NEW YORK MEETING OF THE AMERICAN CHEMICAL SOCIETY

A MEETING of the American Chemical Society will be held in conjunction with the Second National Exposition of Chemical Industries, September 25 to 30, inclusive. A council meeting is called for Monday afternoon and Monday evening. A general meeting follows on Tuesday morning, and on Tuesday afternoon it is hoped to have a public meeting in the large hall at the City College, with addresses by prominent men bearing upon "Chemistry and the National Welfare." On Tuesday evening a general "get-together" entertainment will be given by the New York Section complimentary to the parent society, to which visiting chemists will be invited. On Thursday evening the Electrochemical Society will give a smoker, to which the members of the American Chemical Society will be invited, and on Friday evening a subscription banquet will be held in one of New York's large hotels.

Meetings of divisions will be held on Wednesday, Thursday, Friday and Saturday mornings. One of the special features of the meeting will be general conferences on special subjects in which the chemists of the country are now interested. The idea of these conferences is to have some important topics such as

Glassware and Porcelain,
Steel Alloy Metals,
Paper and its Utilization,
Oils and Motor Fuels,
Convertibility of Plant,
Medicinal Chemicals,
Dyestuffs and their Relation to Munition Factories,
Industrial Alcohol, Acetone and Formic Acid,

the discussion to be started by some well-known specialists in these lines. No set program is planned for these conferences, but it is believed from past experience that chemists interested in these various lines will get together and many interesting points will be brought out which will be of mutual interest. The topics for these conferences have not as yet been determined upon, and suggestions are desired from members of the society. These suggestions will all be placed before the Program Committee, and some six or eight topics selected therefrom. It is anticipated that two conferences will be in session each afternoon at the same time, one in the lecture hall of the Grand Central Palace, where the Second National Exposition of Chemical Industries will be held, and one in the lecture hall of the Chemists Club.

The president's address will be one of the general papers at the public meeting on Tuesday. The division of biological chemistry, physical chemistry and industrial chemistry will hold a joint symposium on colloids on Wednesday and Thursday mornings. On Wednesday morning the symposium will be of a theoretical nature, in which the industrial division will not take part. On Thursday morning the symposium will be composed of industrial application of colloid chemistry. A symposium on occupational diseases is also planned and is to take up part of one of the morning sessions of the industrial division.

SCIENTIFIC NOTES AND NEWS

A MEMORIAL to Major Walter Reed, of the army, who demonstrated the transmission of yellow fever by mosquitoes, is planned for the campus of the University of Virginia, of which he was a graduate.

PROFESSOR JULIUS STIEGLITZ, of the University of Chicago, and Dr. Leo Baekeland, of New York, were given the honorary degree of doctor of chemistry by the University of Pittsburgh at its recent commencement.

THE degree of D.C.L. has been conferred by the University of Oxford upon Douglas William Freshfield, M.A., University College, president of the Royal Geographical Society.

DR. CHARLES H. MAYO was the guest of honor at a banquet given on June 22, by the citizens of Rochester, in recognition of his

election as president of the American Medical Association. A silver loving cup was presented to Dr. Mayo.

DR. ALBERT SHIELS, director of the bureau of reference and research of the New York City Board of Education, has been elected city superintendent of schools of Los Angeles at a salary of $8,000 a year. The salary formerly paid the city superintendents there was $6,000 a year.

DR. A. A. EISENBERG, formerly pathological anatomist in the U. S. Army Medical Museum and School, Washington, D. C., has been appointed pathologist at Charity Hospital, Cleveland.

PROFESSOR B. E. LIVINGSTON and Dr. H. E. Pulling, of the laboratory of plant physiology of the Johns Hopkins University, will spend the months of August and September in the region of Fort Churchill and Port Nelson, Hudson Bay. They will carry out field studies of vegetation as related to soil and climate.

MISS ALICE EASTWOOD, curator of the botanical department of the California Academy of Sciences, spent five days, from June 15 to 20, collecting at the Grand Canyon of the Colorado. The Hermit Trail was traveled to the bottom of the canyon, and the Grand View or Berry Trail for about two miles down. The Bright Angel Trail had been explored previously by Miss Eastwood. About 270 species were collected.

PROFESSOR GEORGE NEILL STEWART, director of the Cushing Laboratory of Experimental Medicine, Western Reserve University, will sail for England on July 22.

MISS ETHEL GERTRUDE EVEREST, of Chippens Bank, Hever, Kent, daughter of the late Colonel Sir George Everest, surveyor-general of India, has left the house on her estate to the National Trust to be used as a home of rest for tired brain-workers, particularly writers and artists. The land round the house has also been bequeathed to the National Trust to be used as a public park for the use of the nation, and as a "bird sanctuary," where bird-life shall be encouraged, together with £8,000 for the maintenance of the estate.

DURING the week of September 25 the Second National Exposition of Chemical Industries will be held in New York. The American Electrochemical Society will be one of the national societies which will meet in New York during the same week. Its meetings will be held on September 28, 29 and 30, and the outline of the program has just been announced. It is as follows:

Wednesday, September 27, evening: General reception, with registration at the Chemical Exposition, Grand Central Palace.

Thursday, September 28, forenoon: Reading and discussion of papers, general subject: "Made in America."

Afternoon: Visiting the exposition.

Evening: Complimentary smoker. An invitation will be extended to the members of the American Chemical Society and other visiting chemists and engineers.

Friday, September 29, forenoon: Reading and discussion of papers.

Afternoon: Visiting the exposition.

Evening: Subscription dinner-dance.

Saturday, September 30, forenoon: Reading and discussion of papers.

Afternoon: Visiting the exposition.

THE graduates of the course in public hygiene of the University of Pennsylvania have recently organized as an Alumni Association. The university was a pioneer in the field in this country and has been offering instruction for public health positions since 1906. In 1910 they graduated their first doctor of public hygiene, Dr.P.H., and at present the graduates of this course number twenty-six physicians, with the degree Dr.P.H. and two engineers with certificates as certified sanitarians. Of the physicians three are women. These graduates are widely scattered, in India, Siam, China, Philippine Islands, Hungary and England, in the United States from California to New Jersey and in the U. S. Army and Navy medical services. Their occupations range from medical missionaries through scientific research, epidemiology, sanitary engineering, municipal health officers, labor departments, housing commission and tuberculosis prevention work to special hospital work and teaching in public health and allied lines.

Recent appointments to the Office of Investigations in Forest Pathology, Bureau of Plant Industry, are as follows: Samuel B. Detwiler, formerly field superintendent of the Pennsylvania Chestnut Tree Blight Commission, has been appointed forest inspector in charge of field work on the white pine blister rust. Reginald H. Colley, lately assistant professor of botany in Dartmouth College, and Minnie W. Taylor, lately assistant in botany in Brown University, have been appointed agents to assist Dr. Perley Spaulding in research on the white pine blister rust. Paul V. Siggers, lately a graduate student in botany in the University of Michigan, and Gilbert T. Posey, research assistant in botany at the Oregon Experiment Station, have been appointed scientific assistants to Mr. Detwiler. George L. Barrus and Norton M. Goodyear, recently engaged in commercial forestry, have been appointed agents also assisting Mr. Detwiler. In addition to these more or less permanent appointments, about forty field agents have been appointed for temporary periods to work on the white pine blister rust in cooperation with various state officials. Field work on the white pine blister rust east of Ohio is organized under the general direction of Mr. Detwiler; west of and including Ohio, under the general direction of Mr. Roy G. Pierce.

Sir Ernest Shackleton, who, on returning from the South Polar zone last April, left twenty-two of his companions on Elephant Island, sailed on July 18 from Punta Arenas, Chile, on a small schooner, hoping to rescue them. If conditions are favorable, Sir Ernest expects to relieve the explorers and to return to Chile in four weeks.

The final meeting for the session of the University of Pennsylvania Chapter of the Society of the Sigma Xi, was held in the electrical engineering department, President E. C. Kirk presiding. Addresses on "Illumination" were given by Professor C. L. Clewell, from the engineering standpoint, illustrated, and by Professor George E. de Schweinitz, from the standpoint of the ophthalmologist. The following officers for 1916–17 were elected: *President,* Warren P. Laird, professor of architecture; *Vice-president,* C. E. McClung; *Treasurer,* J. Percy Moore; *Recording Secretary,* S. P. Shugert; *Corresponding Secretary,* W. H. F. Addison.

Plans are now being completed for the eighty-sixth annual meeting of the British Association, this year to be held at Newcastle-on-Tyne in the first week of September, as has been already noted in Science. Sir Arthur Evans, the archeologist, taking the chair in succession to Professor Arthur Schuster, will deliver his presidential address on September 5. This year's sectional presidents will be: Mathematical and Physical Science, Professor A. N. Whitehead, of the Imperial College of Science; Chemistry, Professor G. G. Henderson, Glasgow; Geology, Professor W. S. Boulton, Birmingham; Zoology, Professor E. W. Macbride; Geography, Mr. D. G. Hogarth, keeper of the Ashmolean Museum, Oxford; Economic Science and Statistics, Professor A. W. Kirkaldy; Engineering, Mr. G. G. Stoney, Newcastle; Anthropology, Dr. R. R. Marett; Physiology, Professor A. R. Cushny, University of London; Botany, Dr. A. B. Rendle, of the British Museum; Educational Science, the Rev. W. Temple, rector of St. James's, Piccadilly, and formerly headmaster of Repton School, and Agriculture, Dr. E. J. Russell, director of the Rothampsted Experimental Station at Harpenden. Evening lectures will be given by Dr. Chalmers Mitchell, secretary of the Zoological Society, on "Evolution and the War," and by Professor W. A. Bone on "Intensified Combustion."

Major R. Tait Mackenzie, R.A.M.C., professor of physical education, University of Pennsylvania, opened a discussion on the necessity for a national scheme of physical education, at a meeting of the Royal Sanitary Institute, at the Municipal School of Technology, Manchester, on July 7.

The collection of ethnological remains brought from South America by Dr. W. C. Farrabee will require more than three months to arrange, and therefore will not be on exhibition until next fall. The expedition, which was headed by Dr. Farrabee, extended over a

period of three years, and cost more than $100,000.

UNIVERSITY AND EDUCATIONAL NEWS

THE Yale University School of Medicine will receive $14,845 by the will of Norman B. Bayley.

THE new master of Magdalene College, Cambridge, Mr. A. C. Benson, has established a Charles Kingsley lectureship in natural science in the college with an income of £150.

A SCHOOL of applied social sciences will be opened at Western Reserve University, at the beginning of the next academic year. It will be a graduate school with a two-year course, in which supervised field work will be an essential part of the plan.

AT the University of Cambridge the proposed grace relating to the admission of women to the first and second M.B. examinations and the examination in architectural studies has been withdrawn, in order that reports on the subjects may be presented to the senate by the boards concerned.

MR. J. H. HILL has been appointed professor of mathematics at the Ohio Northern University.

R. L. DAUGHERTY has been appointed professor of hydraulic engineering at Rensselaer Polytechnic Institute. He has for the past six years been assistant professor of hydraulics in Sibley College, Cornell University. He succeeds at Rensselaer Professor Lewis F. Moody who has gone into private practise. Professor Daugherty is the author of "Hydraulic Turbines," "Centrifugal Pumps" and "Hydraulics." He graduated from Leland Stanford University in 1909 and was an instructor in experimental engineering there the following year.

THE following appointments have been made to the medical faculty of New York University: clinical professors of surgery, Drs. Joseph B. Bissell, Thomas A. Smith, Walter C. Cramp and Arthur M. Wright; professor of clinical surgery, Dr. William C. Lusk; chief of clinic, department of surgery, college dispensary and instructor in surgery, Dr. W. Howard Barber; instructor in surgery, Dr. George Francis Cahill; clinical professor of medicine, Dr. Theodore J. Abbott; instructor in medicine, Dr. Hubert V. Guile; clinical professor of cancer research, Dr. Benjamin M. Levine; assistant professor of bacteriology and hygiene, Dr. Charles Krumiede, and instructor in bacteriology, Miss Mary Smeeton.

DISCUSSION AND CORRESPONDENCE

BEES AND MENDELISM

SOME confusion of thought as regards Mendelian expectations is apparent in Mr. Quinn's article[1] dealing with his interesting observations on the inheritance of body color in crosses of Italian with Caucasian bees. Mr. Quinn considers that his observations are not in accord with those of Newell because the latter concluded that "the production of an F_1 (heterozygous) drone seems to be an impossibility and this, in turn, makes the production of a strict F_2 generation look like another impossibility." But Quinn reports obtaining a typical 1:2:1 ratio of pure yellow: heterozygous yellow: pure gray queens in F_2, which he considers evidence that the drones as well as the queens of the F_1 generation are heterozygotes. This would indeed be true if a single F_1 queen mated with a single drone gave the result stated. But Quinn does not so report the facts. His statement apparently applies to the F_2 queens considered collectively, not to those produced by a single F_1 mother. If, as both Newell and Quinn suppose, all F_1 queens are heterozygotes and produce equal numbers of I and C gametes, and if they are mated some with pure I and others with pure C drones, then the expectation as regards their female offspring is that actually observed by Quinn. For a mating with a pure I drone should produce 1 II + 1 IC zygotes; and a mating with a pure C drone should produce 1 IC + 1 CC zygotes; and if the two kinds of matings are equally productive, their combined result would be 1 II + 2 IC + 1 CC, as reported by Quinn. It is therefore unneces-

[1] SCIENCE, June 30, 1916.

sary to assume from the facts reported that the drones of the F_1 generation are heterozygous as regards color. If this fact were established, it would disprove the Dzierzon theory, which is supported by so many distinct lines of evidence and thus far contradicted by none. A very direct test of the assumption that F_1 males are heterzygous could be made by mating them with queens of pure race. Such matings should produce mixed broods, if the drones are indeed heterozygous, but otherwise not.

We may conclude that the facts reported by both Newell and Quinn are credible since (1) they are really not at variance with each other, (2) they have been made independently by experienced observers in the wonderfully favorable environment of Texas and (3) their observations accord with previous knowledge. The credibility of Quinn's report is increased, not lessened, by the fact that he supposed his observations were at variance with prevalent theories.

Quinn's observations do not call in question the Mendelian inheritance of yellow body-color in crosses, but Newell reported some facts which might lead one to doubt the completeness of segregation in all cases, such as the production of drones of intermediate color. The orthodox Mendelian and the devotee of "exact" heredity will probably close his eyes to such troublesome facts, but the student of heredity who is not convinced of the finality of present knowledge might do well to keep them in view.

William E. Castle

Bussey Institution,
July 1, 1916

NOTE ON A MORAINE IN NORTHWESTERN NEW ENGLAND[1]

A recessional moraine consisting of several separate segments disposed along a sinuous course lies near the Atlantic coast, and has been traced through 60 miles from Saco, Maine, to Newbury, Mass. It stands for the most part at about or less than 100 feet above sea level, but rises to 150 feet in Dover, N. H., and Newburyport, Mass., and to between 200 and 250 feet in Wells and South Berwick, and although not more than 40 to 100 feet higher than surrounding Pleistocene formations, it is topographically prominent. The moraine rests upon and is surrounded by a floor of ice-smoothed rock and of till. During the building of the moraine the region was submerged so that the ice front stood in the sea. The moraine is the result of accumulation of glacio-fluvial detritus discharged directly into the sea; consequently in some places it is built up as broad, flat, delta-like plains. Clay ("Leda clay") which is glacial outwash was continuously deposited in the sea both while the moraine was building and also after the ice retreated from the moraine, so that the younger clay beds in some places overlie the moraine. The moraine and the marine clay probably belong to a late Wisconsin sub-stage of the Pleistocene epoch.

Further description and discussion of this moraine will appear in a paper to be published by the United States Geological Survey.

Frank J. Katz

[1] Published by permission of Director of U. S. Geological Survey.

NEPTUNIUM

In response to Professor Emerson's request for information concerning this element I beg to present the following:

Neptunium was announced by K. Hermann in 1877 (Pharm. Central H., June 7, 1877, p. 186, through the *Proceedings of the American Pharm. Assn.*, 1877, p. 268).

It is described as belonging to the "tantalum group," of the atomic weight 118, and as occurring in certain rare earths associated with tantalum and niobium.

J. F. Couch

Des Moines, Iowa

SCIENTIFIC BOOKS

Psychological Effects of Alcohol. An Experimental Investigation of the Effects of Moderate Doses of Ethyl Alcohol on a Related Group of Neuro-muscular Processes in Man. By Raymond Dodge and Francis G. Benedict, Carnegie Institution of Washington, Washington, D. C., 1915.

There is no more unsatisfactory chapter in the history of physiological psychology than that concerned with the action of alcohol. Most of the work on this subject has been done in the interests either of temperance or "beer," and shows in a striking, at times even in a grotesque, manner the failure so frequent in scientific work carried out with an immediate practical aim. It is therefore a matter for congratulation that the investigation of the physiological and psychological effects of alcohol should have been undertaken by so wholly independent a body as the Carnegie Institution and by an investigator so evidently free from practical as opposed to scientific interest as the director of its department of nutrition.

The book under notice, which is the first-fruits of this research, must be regarded as "survey" rather than "intensive" work, to borrow terms from another science. It covers an extensive field in which the action of ethyl alcohol is tested on a number of processes including the patellar and eyelid reflexes; the reaction of the eye to peripheral visual stimuli and the reaction-time in reading; the psychogalvanic reflex and the process of free association; the process of memorizing; the sensory threshold for faradaic stimulation, the velocity of eye-movements and of movements of the finger; together with observations on pulse-rate made concurrently with the other investigations.

The main result of the work is to show that wherever alcohol has an appreciable action, it is on the average depressing, and that this effect is greater on the simple motor, sensory and reflex processes than on those in which the higher parts of the nervous system are more directly involved.

The aim of the work has been to test the influence of alcohol upon a series of neuro-muscular processes. The authors have chosen for this purpose processes which they believe to be simple and customary with the avowed aim of excluding such factors as practise and interest. They hardly seem to have realized that the factors thus excluded are just those which from the title of the book we should expect to find the special object of study. The research is really one on neuro-muscular process preliminary to the study of the psychological effects of alcohol rather than such a study itself.

It is a question how far the authors have succeeded in their efforts to attain the simple. It is unfortunate, with this end in view, that they should have chosen the knee-jerk, for though this reaction is now generally regarded as a reflex, it is one of a very special kind, depending as it does upon a condition of muscular extension. Still less appropriate from this point of view are the observations which the authors have, not very happily, named after the process of reciprocal innervation and have regarded as tests of muscular coordination. It is unfortunate that in their search for the simple they should have chosen a process in which the examination of reciprocal innervation in Sherrington's sense involves a highly elaborate process of cortical activity. They have also departed widely from their principle of customary reaction for the movement of the finger which they measure is one of a highly artificial and unusual kind.

The foregoing criticisms are concerned with the general choice of the means by which neuro-muscular activity has been tested. With regard to the methods employed for this purpose the chief criticism to be offered is that the authors have depended too much on the time-relations of the processes they study and too little on their accuracy and on the adequacy with which the movements fulfil their functions. Otherwise little objection can be raised to the technique of the observations. In such survey work in which a number of subjects were employed, it was perhaps impossible to regulate their lives more completely and thus bring the research nearer to the ideal of the method of difference, but this regulation should not be neglected in more intensive work. Similarly, the disuse of control-mixtures is of little importance in work from which psychological factors have been so largely excluded, but it is to be hoped that this precedent will not be followed when psycho-

logical processes become the special object of research.

Less satisfactory than the experimental technique is the statistical treatment of the results. Serious objection must be taken to the misuse of the average. It is wholly misleading, for instance, to give 22 as the average of the three measurements, $+85$, -9 and -11. This figure is held to show that three so-called psychopathic subjects, *i. e.*, men who had been intemperate, did not differ to any extent from seven normal subjects. Really, the figures only show that of three formerly intemperate subjects one was far more sensitive than usual to the depressing effects of alcohol on the eyelid reflex, while the other two subjects resembled one out of the seven normal men in showing the stimulating effect of 30 c.c. of ethyl alcohol. This and other measurements on the intemperate subjects serve to confirm the statements made in their personal histories, that one was unusually sensitive to the influence of alcohol, while the others were less sensitive than usual, not, it is probable, on account of psychopathy, but through their former habituation to the action of alcohol. In so far as any weight can be attached to the apparently stimulating effect of alcohol in these two subjects, it may have been due to the satisfaction of a craving.

This work is the first contribution to an investigation of the action of alcohol which it is to be hoped may extend over many years and go far to settle a number of obscure and difficult problems. I have ventured to call attention to certain points of methodology and workmanship which seem to require reconsideration because in such an investigation principles and methods can not be too closely scrutinized at the outset. The criticisms now offered must not be allowed to obscure the recognition of the great value and promise of the work.

W. H. R. Rivers
University of Cambridge

Typical Flies—A Photographic Atlas of Diptera, including Aphaniptera. By E. K. Pearce. Cambridge (England), University Press, 1915.

This royal octavo, bound in boards, contains 4 pages of preface, 4 pages of classification; 45 pages of half-tone reproductions from photographs, comprising 155 figures representing 125 species distributed in various families, including 4 species of fleas, and 3 fly habitats; concluding with 2 pages of index. Under the figures are given technical name of the species, common name, if any, length of body, wing expanse, with brief data on habits and habitats.

The book is intended to fill the place of a pictorial elementary treatise. The plan is an excellent one, but difficult of proper execution. The author complains of the difficulties which he encountered in obtaining suitable material for photographic reproduction. Nevertheless, the figures are all quite recognizable, which is the main requisite to the success of the plan. The feature of including habitat photographs is commendable and might have been farther pursued.

There is no doubt that the wings and legs of flies must be spread in order to photograph them to the best advantage, but care must be exercised to secure natural attitudes, just as in the mounting of birds, mammals and other animals. Otherwise the reproductions are not true to nature but leave a marred image upon the memory, which appreciably reduces facility of recognition of the species in its habitat.

Recommendations made by the author in his preface regarding methods of mounting are open to objection. Aside from material for photographing, and the proper setting of the proboscis and hypopygium for study in certain forms, the reviewer decidedly favors leaving all flies in the natural attitudes assumed by them in the killing bottle. Specimens too small to be pinned with a No. 2 pin should be mounted on minute wire elbows wound on No. 3 pins. Only 34 to 39 mm. pins should be used, longer sizes giving trouble in the standard-depth cases. Great care should be taken not to get the specimen too high on the pin, but to leave sufficient room for grasping the head of the pin with the thumb and finger without danger of contact with the wings or other parts. There should be left sufficient space on the pin below the specimen for several labels, which

should be right side up that they may be read without the necessity of removing the specimen from the tray or case. In no instance should flies be gummed or mounted in any manner on cards, which are certain to obscure important characters.

Revision of other recommendations which occur in the preface should be made. Fine-mesh bobbinet is the proper material for nets; and white is the preferable color, facility of locating the fly in the net after capture outweighing any element of alarm to the fly prior to capture. In fact, the white net is very attractive to many flies, rare species often alighting thereon voluntarily in the field. As to size, the 22-inch diameter bamboo ring set in an unjointed three-foot light wooden handle is the most effective, specimens rarely escaping it even if the cast is made during flight. This is the net used by the veteran English field-naturalist, Mr. A. E. Pratt, in South America and New Guinea. It is sufficiently light to be easily wielded in one hand, and performs exceptional service.

The fly is best transferred directly from the net to the cyanide vial. The latter should be the 25 x 100 mm. flat-bottom clear-white shell vial, the cyanide enclosed in a wad of tissue paper and tightly wedged into the bottom, shredded tissue paper being placed loosely in the vial to prevent undue rubbing and contact of specimens, and closed with a soft cork stopper. Large and small flies should go in separate vials; such forms as bombyliids with pile that is easily detached must be kept separate, as well as culicids and other forms that might be injured by stouter flies or that might mess others with their scales, pile, exudations, or pollen. The judgment of the collector must guide him, and he should carry a liberal supply of the vials. The specimens may be left all day in such vials without injury, but should be pinned the same evening or at latest next morning. In dry climates they will not last well over night.

In giving measurements of flies, the length of one wing, and not the expanse, should be stated. The expanse is not a stable quantity, due to drying and faulty spreading; moreover, the wings of study material should not be spread.

As to the classification adopted, it is especially important to present a correct system in a work intended for beginners. Most systematists will criticize the inclusion of the fleas with the Diptera. The superfamily Muscoidea is made to include the entire calyptrate and acalyptrate divisions. The superfamily name *Cypseloidea* should be applied to the acalyptrate groups, while *Muscoidea* should be restricted to the higher calyptrates. The Muscoidea of the author are stated to produce ova as a rule, but there are very extensive groups of the higher calyptrates that deposit larvæ; in fact, the larvipositing species of calyptrates will probably easily exceed in number the ovipositing species. The Nematocera has recently been shown by Knab and others to be an unnatural group. In the pages of half-tone reproductions, the Cyclorrhapha are divided into Proboscidea and Eproboscidea, the latter comprising the Pupipara as opposed to all the other Cyclorrhapha; an unnatural arrangement, since the main Pupipara show close affinity with the Cypseloidea and not with the Syrphoidea. The Phoridæ are wrongly included in the acalyptrate series. The Bombyliidæ, and not the Braulidæ, are commonly termed "bee-flies."

With these few friendly criticisms, the book is commended as a very useful means of presenting objective instruction in dipterology.

CHARLES H. T. TOWNSEND

SPECIAL ARTICLES

A SIMPLE AND RAPID METHOD OF STUDYING RESPIRATION BY THE DETECTION OF EXCEEDINGLY MINUTE QUANTITIES OF CARBON DIOXIDE

IN order to arrive at a satisfactory knowledge of life-processes, it is necessary to have accurate quantitative methods by which the measurement of these activities can be made. One of the best means of accomplishing this is found in the study of respiration. The production of CO_2 is regarded[1] as the only reli-

[1] *Cf.* Tashiro, S., *Amer. Jour. of Physiology*, 32: 107.

able universal expression of respiratory activity in anaerobic and aerobic tissues in normal condition.

It is extremely important to possess a method of detecting very small quantities of CO_2 as it is given off by the organism in the normal environment. The excellent methods devised by Tashiro[2] for the detection of very minute quantities of CO_2 are unfortunately limited to the study of tissues which are not bathed by solutions. But many of the most important studies on respiration require that the tissues shall be immersed in solutions in order to measure the effect of dissolved substances on respiration. Moreover the methods of Tashiro do not enable us to determine the quantities of CO_2 produced from moment to moment as the reaction goes on and thus to construct the time curve, which is, in most cases, of primary importance.

These difficulties are overcome by the method here described. The method consists in adding an indicator to the solution containing the tissue and observing its color changes.

The indicator should possess the following qualities: (1) it should be non-toxic to the material; (2) it should not rapidly penetrate the tissues; (3) it should be sensitive to very slight increases in the hydrogen ion concentration due to CO_2; (4) it should have a suitable working range.

Phenolsulphone-phthalein with a range of color changes from PH^+ 6.5 to PH^+ 8.5 but with extremely sharp differentiations in color between PH^+ 7.0 and PH^+ 7.5, has been found to be very satisfactory.[3] Other indicators of various ranges of color change, such as phenolphthalein, alizarin sodium sulphonate, etc. (sulphonic acid salts being not readily absorbed by cells), are being studied as to their usefulness for such work.

When salts occur in the solutions used, the salt error for the indicator should be taken into account. Some indicators can not be used with certain salts on account of being precipitated out of solution, but experimentation alone can tell which, in the large list of accurately described indicators,[4] are best adapted to a particular need.

If the material is of the nature of seeds, algæ, or aquatic animals, the whole of which can be submerged, the following procedure is followed: A tube of non-soluble or Pyrex glass of the desired diameter and length (for small seeds, algæ, etc., 16 mm. diameter by about 4 to 5 cm. long is very satisfactory; tubes below 16 mm. diameter are not recommended) is closed at one end by fusion. A piece of rubber tubing about 7 cm. long is attached at the open end. It is best to boil the rubber tubing repeatedly previous to using it, in order to insure thorough cleanliness. The rubber tube, while attached to the glass tube, is dipped a few seconds into hot paraffin so as to put a thin coat on both sides of the rubber. The best grade of paraffin (58°–62° C. melting point) is used, and serves to prevent the rubber from possibly giving off substances to the solution and also is advantageous in giving a seal against the CO_2 of the air. Ordinary soft glass tubing (which gives off alkali) or parawax (which gives off acid) is not suited for accurate work. Pyrex tubes, in the absence of Jena glass, can be used to advantage, especially because all sizes can be obtained.

The material to be studied is placed in the glass tube with a definite number of c.c. of solution containing a definite number of drops of an indicator of known strength. The volume of solution used is always made as small as possible, consistent with the requirements for colorimetric work, but however small the volume of solution used, slightly more than enough to fill the glass tube must be taken. The paraffined rubber tube is then closed with two strong pinchcocks so as to exclude all air from contact with the solution. The paraffin on the rubber tube is prevented from becoming brittle before it is clamped, by working rapidly or if necessary by the use of a lukewarm water bath. In this case the CO_2 in the solution is

[2] Tashiro, S., *Amer. Jour. of Physiology*, 32: 137; *Jour. Biolog. Chem.*, 1914, p. 485.

[3] Lubs, H. A., and Clark, W. M., *Jour. Wash. Acad. Sci.*, Vol. V., No. 18, November 4, 1915.

[4] Höber, "Physik. Chem. der Zelle und der Gewebe," 1914, p. 171.

in equilibrium with the CO_2 of the air before the tube is clamped. The closed tube is inverted several times and the color of the solution is compared with a series of buffer solutions of known hydrogen ion concentration and the acidity at the beginning of the experiment is recorded. The tube can be put on a shaker, should conditions require it, and after any interval whatsoever, the tube is inverted a few times in order to stir the liquid and to get a uniform color throughout the solution and then by comparing it with the buffer solutions, the increase in hydrogen ion concentration is noted. This can be repeated any number of times and at any interval of time. Changes in the hydrogen ion concentration as small as from 2×10^{-6} to 1×10^{-6} can be detected in this way.

Much smaller differences in the hydrogen ion concentration of a solution can be detected by using distilled water nearly or entirely free from CO_2, or by using solutions in which the hydrogen ion concentration is low. The procedure when pure distilled water is used is the same as that just given except that while the tube is still in the bath ready for clamping, a CO_2-free gas is bubbled through the solution until, by comparison with the buffer solution, it is known that the solution in the tube is between PH^+ 7.0 and PH^+ 8.0. The tube is then clamped off as before and the hydrogen ion concentration is read at intervals by comparison with buffer solutions. If the solutions, due to added reagents, are quite acid, then the smallest amount of CO_2 that can be detected is increased. However it is often possible to add the same amount of alkali to each tube so as to decrease the hydrogen ion concentration at the start and in this event the method can become extremely sensitive so as to detect minute traces of CO_2. This is also true of many solutions in which the hydrogen ion concentration is very small.

When the respiration of roots is studied, the glass tube has both ends open and tubing on each end. The roots are inserted into one (very short) paraffined rubber tube, and by means of a pinchcock, the tube is clamped so that only a small space is left about the stalk as it protrudes. A low melting mixture is used to make the final seal about the plant. After the plant has been inserted, the paraffined tube is attached at the other end. The solution is then run in and the CO_2 expelled by bubbling hydrogen through. The paraffin, before clamping takes place, should be rather soft and pliable, and should it tend to become brittle it can be kept soft by being kept inside of a tube open at both ends and which is kept warm by a surrounding water bath. After clamping, readings are made as usual.

When the liquid used is pure distilled water, and is quite free from CO_2, a change in the hydrogen ion concentration as small as from 2×10^{-8} to 3×10^{-8} can be noted. The smaller the hydrogen ion concentration of the solution at the start of the experiment, the more minute the differences which can be detected. If the experiment is started with the solution in equilibrium with the CO_2 of the air, it is possible to ascertain whether or not the increased acidity has been due to the giving off of CO_2 or to acid excretions other than CO_2, by pouring the solution into another tube and (after shaking without the material) letting the solution come again into equilibrium with the air, and noting whether or not the solution returns to its original hydrogen ion concentration. Furthermore, by bubbling a CO_2-free gas through the solution at the end of the experiment and through a sample of the original solution, it is possible to find out whether acids other than carbonic acid have been given off. If at the end of an experiment it is found that acids other than carbonic acid have been given off, or that an unequal absorption of ions has taken place, so as to produce acidity, then the increase in the hydrogen ion concentration due to CO_2 can be obtained by subtraction. As it is important to know whether acids other than carbonic are given off by plant and animal tissues, experiments have been conducted upon the excretion of acids by plant tissue, the results of which will appear at a later time.

When it is desirable not to have the indicator in the solution during the experiment,

the method can be modified as follows. One end of the glass tube has a paraffined plug having two holes, while the other end has the usual paraffined rubber tube. One hole can be sealed shut if no stem is to protrude, while in the other hole a small glass tube containing the required number of drops of indicator is inserted with a solid glass plunger of equal diameter adjoining, and protruding from the plug. At the end of a given time the indicator is pushed into the solution by means of the airtight plunger and the reading is made rapidly. In such a modification, control tubes must be depended upon to give the hydrogen ion concentration of the solution at the start of the experiment, and, moreover, only one reading can be made from a single tube.

Pure block tin collapsible tubes have been found to be very useful but are very difficult to seal as compared with the paraffined rubber which is easily sealed. Experiments with seeds were run for an hour without any change in the control, and even though it may be possible to run experiments a much longer period without change in the control, yet it appears advisable to cut down the time of an experiment whenever possible; this the new method permits.

In making up buffer solutions,[5] the writer has found it advisable to recrystallize chemically pure salts several times, and whenever possible it is best to check up the accuracy of the buffer solutions with the aid of the hydrogen electrode.

The writer has found that a constant source of light such as has recently been described in SCIENCE[6] is almost indispensable for this work.

By using seeds with the coats removed and a relatively small amount of solution a color change can easily be detected within five minutes.

By this method we can compare the respiration of organisms in different solutions with great accuracy without knowing the actual amounts of CO_2 given off. We need only to compare the times required to produce the same change of color in the solutions. If we use a substance in solution which affects the change of color in the indicator, this substance must be added to the set of buffer solutions. If, for example, we are studying the effect of NaCl on the respiration of roots we put one lot of roots into a solution of NaCl and another lot into distilled water. We then prepare a set of buffer solutions to which we add NaCl so as to make its concentration the same as in the solution containing the roots. We add the same amount of indicator to the solution containing the roots and to the buffer solutions, and the changes of color are then comparable. We proceed in the same way with the distilled water or with any other solutions employed.

If we wish to know the actual amounts of CO_2 given off we may calibrate the indicator by a very simple method, as yet unpublished, due to Henderson and Cohn. We may then use an indicator which passes through a well-defined series of color changes as the amount of CO_2 increases. By observing these changes we can plot the amount of CO_2 against time. The resulting curve enables us to study the dynamics of the reaction and this is of primary importance for an understanding of the processes involved in metabolism.

SUMMARY

1. Respiration may be accurately followed by observing changes in the color of indicators added to solutions which contain organisms.

2. Exceedingly small amounts of CO_2 may be determined in this way with great accuracy.

3. As changes in color often occur in five minutes, the experiments may be shortened so as to exclude pathological changes in the organisms.

4. The simplicity of the apparatus makes it possible to carry on a large number of experiments at the same time.

5. The amounts of CO_2 produced in successive intervals can be determined without disturbing the organism. This enables us to study the dynamics of the process.

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[5] Michaelis, L., "Die Wasserstoffionen-Konzentration."

[6] SCIENCE, N. S., 42: 764, 1915.

SCIENCE

FRIDAY, JULY 28, 1916

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

THE CONTRIBUTION OF MEDICAL SCIENCE TO MEDICAL ART AS SHOWN IN THE STUDY OF TYPHOID FEVER[1]

I INTERPRET the gratifying invitation of the Academic Senate to appear before you as faculty research lecturer for the current year not only as an opportunity of assembling and correlating a group of facts that I have been studying, but also as allowing me to attempt an explanation of the method by which such facts are obtained. I wish in particular to suggest how one of the more theoretic or so-called scientific branches of medicine is utilized in the practical problem of preventing and curing disease.

There is little reason that many of you should have attempted to differentiate between medicine as an art and medicine as a science. Public interest and concern in medicine deals with it largely as it is applied to the individual or community and little with the scientific and more theoretic investigations on which the progress of applied medicine depends. Medicine to the layman is typified in the physician who attends him and it is the noble and satisfactory function of this individual to ease the mind and body of his patient and frequently so to apply his knowledge of human structure and function in health and disease as to avert death and hasten recovery. The practitioner employs the art of medicine, that is to say he combines, modifies and adopts certain recognized means to

[1] The annual faculty research lecture at the University of California, delivered on Charter Day, March 23, 1916, on invitation of the Academic Senate.

effect a given end. There exists, however, a type of work in medicine with which the public comes less in contact and which concerns itself primarily with the fundamental understanding and elaboration of those very means of prevention, relief and cure which the physician applies.

It would naturally occur to you that the individual best fitted to discover means of understanding and thereby of combating disease, would be one fully conversant with its manifestations and results through constant and persistent contact with the sick. Such, indeed, was the development of medical science through many centuries. I need only mention categorically a few of the great discoveries that have been made during the centuries by practising physicians. Galen, in the second century of our era, showed that control of the muscles depends on integrity of the nerves that run to them, by the simple experiment of cutting certain of them in animals. In the sixteenth century Versalius not only founded the science of anatomy, but described the mechanism of breathing and introduced artificial respiration. Harvey in the seventeenth century experimentally demonstrated the mode of circulation of the blood in the animal body. Thomas Young laid the foundation of physiological optics and explained the principle of color differentiation. Jenner showed conclusively that inoculation with cowpox will protect against smallpox, and thereby laid the foundations of vaccination as a preventive of many infectious, parasitic diseases. Morton, in the last century, discovered the principle of anesthesia, which has made surgery painless.

You will notice that these examples consist entirely of contributions which may be regarded as fundamental principles rather than adaptations of such principles, however practically valuable; in other words, it is a list of discoveries rather than of inventions; on such basis I have omitted Lister's great application of Pasteur's principles of bacterial contamination in aseptic and antiseptic surgery. You may further observe that the contributors cited have worked on experimental rather than purely deductional lines; I have not, for instance, mentioned the important work of Auenbrugger, who associated certain percussion notes over the chest wall with diseased conditions in the lungs and heart. I trust I shall be able to convince you that essential advance in medicine, as in other biological sciences, lies in the development of principles through inductive experimentation.

In the popular mind and in popular fiction it is still the well-known practitioner who is the great contributor to medical science. As a matter of fact to-day, and for many years, the progress has been largely due to a group of workers who are concerned little, or often not at all, with the care of the sick. Many major discoveries have been made by men with no medical training at all. I may simply mention among the latter Pasteur and Metchnikoff, whose contributions we shall later consider in more detail. This differentiation in medicine of a group of medical or even nonmedical men from medical practitioners, is a specialization or division of labor that is unknown to or misunderstood not only by the general public, but even in the medical profession itself. Its development is, however, quite logical and tending toward greater efficiency.

Progress in medical treatment a hundred years ago, and to a great extent fifty years ago, depended almost entirely on deductions that were ingeniously made from personal experience with the sick. The greater such an experience was the greater and more complete the series of facts obtained, the more valuable the deductions from them. Nothing approaching a complete series of

facts, and particularly of facts in their chronological order, was possible until experimental methods were employed. As Neuberger has stated, collection and observation of fact constitute the first step in science, but not science itself. With the application of the methods that had already been utilized in the sciences of physics and chemistry to biology and medicine, it has often been possible not only to reproduce in animals some particular stage of a disease that has been met with in man, but to study the preceding and succeeding stages in such a process with a completeness that could be afforded in the sick room only through unlimited experience. Any deductions from the haphazard data of spontaneous disease requires, moreover, unlimited skill in fitting each stage as it irregularly occurs, into its proper place. Deductions from a relatively complete and orderly series of experimental facts are at once more rapidly arrived at and more reliable than empiricism. They have the further advantage of suggesting in their genesis other questions that have perhaps never arisen in clinical experience, the answers to which may, however, greatly simplify the problems of medicine.

When once the fruitfulness of the study of medical problems by methods already employed in the exact sciences became evident to the thoughtful physician, innumerable questions arose in his mind which he felt sure could now be answered. He felt, let us say, that animal experiments could tell him the exact relation between a shrunken and diseased kidney, a thickening of the arteries and an enlargement of the heart, a combination frequently found associated, and once the exact relation was known, particularly as to which came first, he felt some method of arresting or preventing the process might finally be obtained. At first the more ambitious and able practitioners endeavored to answer these questions for themselves, working in their laboratories into the still hours of a morning that ushered in another day spent at the bedside and the operating-table. These giants exist even to-day and it is owing to their example, enthusiasm and aid, that some of us are now able to carry on their work with greater single-mindedness and under less heroic conditions of existence. As the facts have accumulated and the methods of these newer sciences have been elaborated, it has become increasingly more difficult for one with divided interest to understand and particularly to add to them. Twenty-five years ago the professor of anatomy was a surgeon; the professor of pathology a practitioner of medicine. These men were often able and brilliant teachers of subjects which were their avocations rather than their true professions. They were even contributors to sciences which in their incompleteness made the finding of new facts easy. As the mass of acquired facts became larger, the gaps between them shorter but more difficult to fill, and the stimulus to further discovery greater, men one after another slipped from the beaten track of practise to become laboratory workers, usually at a financial sacrifice, because the work appealed to them.

It became evident that the medical sciences require whole-souled devotion. As Dietl expressed it in 1851,

> As long as medicine remains an art it will not be a science. As long as there are only successful physicians there will be no scientific physicians.

It is the practitioner, however, who has created the field for this latter type of worker and who, to a large extent, has made his existence possible.

We have had then for a number of years, two types of workers in medicine—the laboratory man and the practitioner; the

boundaries between them are by no means fast and one crosses readily from one into the other field, but with less and less frequency does one attempt to do both types of work at once. The relations between these workers are highly cooperative, and usually mutually appreciative. The practitioner, as the original patron of the medical sciences, was at first inclined to regard his laboratory colleague as a high-grade technical assistant, and, being closer to the source of human disease problems, he still at times assumes a somewhat ex cathedra attitude as to what problems the medical scientist should investigate. Concerning the actual method of investigation he has, through lack of experience, become tacitly acquiescent. The relation of these workers in regard to the problems themselves is an interesting one and worthy of fuller elaboration.

It is obvious that the practitioner, through constant contact with the sick, knows of more problems that need solution, but through failure to appreciate the limitations of scientific method he does not usually appreciate those problems which can be solved. The clinician is constantly asking the laboratory man for explanations or help that can not as yet be given, and is often surprised when he asks whether *A* and *B* in conjunction will produce a condition *C* to be answered evasively, or told that *D* equals *E*. The clinician has had the tables reversed on him and must perforce content himself with what is given him to apply and not ask for what he would like. A slight misunderstanding each in the other's point of view must arise when we consider the differences in the material with which each man has to deal. The clinician is interested primarily with the needs of individuals, with the problem of a case; the scientist with disease entities, with a complex composed of all the cases of a particular malady that have existed, or that may exist, or frequently with some more abstract line of investigation arising from them. In the first instance the problem, though acute, is a personal and passing one that in the particular case will disappear before the question that has arisen can possibly be answered; in the latter case the solution is acceptable however long it may be in coming. It is easy to understand the impatience of the clinician who wishes results in order that he may apply them to Mr. A, and on the other hand it is reasonable to appreciate the refusal of the laboratory man to be dragged from a promising problem of fundamental import to investigate superficially an ephemeral individual symptom. While it is still possible for the laboratory man to be influenced in choosing his problems, he travels fastest by following attentively those problems which his own work has suggested. It is often more profitable in the end to follow what appear to be irrelevant ramifications rather than to attempt direct determination, let us say of the cause of cancer, or a specific cure for tuberculosis. I venture to say that these questions will not be answered by what we consider direct attack, for it is the habit of nature to respond to our interrogations with apparent indirectness. The real indirectness of course lies in the way we put our questions and not in nature's response. We plan an experiment and await a result which shall be firmly yes or no; the answer is neither of these, but something that throws no light on the original inquiry. Blessed is the man who sees in this incomprehensible reply the starting-point of a new line of inquiry which may take him far afield from the goal he had first in mind. We scientists are like rag-pickers, some fumble through masses of rubbish looking for a certain coin, while the true investigator takes up each object that is

turned over and asks himself what use he can make of it.

Let me illustrate the stages in the evolution of modern medical science from medical art by an outline of the development of our useful knowledge in respect to a single disease, namely, typhoid fever.

Typhoid fever has been, and still remains, one of the significant causes of death and disability. So far as can be shown from the necessarily incomplete statistics of the Public Health Service, there were over 17,000 deaths from this disease in the United States in 1913, which means there were over 170,000 cases, since the mortality averages ten per cent. It is a malady particularly prevalent in crowded groups of men, such as armies and asylums. Sixty per cent. of all the deaths in the Franco-Prussian War were due to typhoid, and in the Spanish-American War one fifth of all the enlisted men contracted the disease, and there were seven times as many deaths from it as from implements of war. And typhoid fever is important not only as a cause of death, but particularly owing to its economic waste; for an acute disease it has a particularly lengthened course and is followed by frequent sequels. It has recently been estimated that the economic loss in this country from typhoid is $50,000,000 annually, as a disease ranking second only to tuberculosis.

Our interest in typhoid fever is heightened by the fact that it is not only an important disease, but one which can and will eventually be obliterated. Recent reports from the Surgeon-General of the United States Public Health Service show that the incidence of this disease is probably not more than half what it was thirty years ago, owing in large part to improved sanitation alone.

Perhaps the one most significant line of advance in medicine has been the gradual recognition of disease entities. On the recognition of separate diseases depends all measures of quarantine, prevention and rational therapy. Diagnosis, the recognition of a disease entity, depends on the patient's symptoms and these symptoms are of two classes; subjective, or those the patient himself experiences as pain, chilliness, and the like; and objective symptoms which the physician can detect. Among the latter may be mentioned rapidity of the heartbeat, fever, eruptions, changes in blood pressure; changes in the blood and urine, and the like. Medical progress has been dependent on the methods of recognizing such constant variations from the normal as are found characteristic of a given type of disease. Such variations were detected at first by the unaided powers of observation, and later by the employment of instruments and methods of precision introduced in the evolution of the medical sciences.

One of the most important symptoms of the parasitic or infectious diseases is a rise in bodily temperature, or fever. A fever is a disease characterized by such a rise in temperature and some fevers continue over a period of days or weeks. The disease we now recognize as typhoid or enteric fever is one of these continued fevers and, although probably seen by Hippocrates, was for centuries confused with other lasting fevers of somewhat similar appearance. Recurrent fever, septic infections, and typhus fever in particular present pictures which even to-day in their beginnings and in their purely clinical aspects may be confused with typhoid.

We owe our first full description of what was probably typhoid fever to an English physician, Thomas Willis, who in 1643 described an epidemic of the disease that occurred in the Parliamentary troops. Early in the eighteenth century Strother, another Englishman, described ulcerations in the

intestine and enlargement of the spleen in that slow nervous fever which we now recognize as typhoid. The effect of this disease in producing a cloudiness or aberration of the mind is what has given it its name, which is derived from the Greek τῦφος or cloud. Its particular nervous or mental effect was further observed by Huxham, who in 1737, on a purely symptomatic basis, separated cases of "putrid malignant fever" (or typhus) from the "slow nervous fever." The final separation of these two confused diseases did not come, however, until a century later and was dependent not only on the recognized differences in the contagiousness and course of the two diseases, but on the recognition of the characteristic and almost inevitable lesions or anatomical changes which are found in fatal cases of typhoid, but never in typhus fever. These lesions, ulceration of the intestine and swelling of the spleen, liver and lymph nodes, mentioned by Strother, were described by Riedel in Germany (1748), Baillie in England (1761) and in particular by Roderer and Wagler (1762). We owe further descriptions of the clinical characteristics of typhoid fever to Bretonneau (1826) who called it "dothienenteritis," or abscess of the small intestine, a name which it frequently bears in French literature, and to Louis (1829) who gave the name "fièvre typhoïde" to the malady.

It is to the great credit of a Philadelphian, William Gerhard, to have given in 1839 a convincing basis of separation between typhus and typhoid fevers. He based this differential diagnosis on accurate descriptions of the greater contagiousness of typhus, the presence of characteristic lesions in typhoid, and on careful comparison of symptomatic differences between the two maladies. His observations, later confirmed in Germany and England, gave us the first basis on which to regard typhoid fever as a separate and distinct disease entity.

The final chapter in the clinical or purely observational study of typhoid fever is represented by two important observations in reference to its transmission from one human being to another. The disease as contrasted with typhus fever was regarded, and properly so, as only slightly contagious, that is, directly transmissible from one patient to another. In 1856 Budd pointed out that the danger of transmission in typhoid, the poison of the disease as he expressed it, lies in the patient's excreta, and in 1873 Murchison actually traced an epidemic to a contaminated milk supply, and showed that the stools of typhoid patients are the principal source of danger in spreading the disease.

This brief statement then outlines the significant advances that were made over a period of centuries in the differentiation and recognition of typhoid fever by purely observational methods, confined to the patients themselves and made by practitioners of medicine. In so far as alleviation of the disease is concerned, there is little or nothing to report beyond purely symptomatic and palliative treatment, the most significant point in which was the introduction of hydrotherapy by James Currie in 1770 and its rediscovery by Brand a century later. The recognition of the danger of spreading the disease through contamination with typhoid excreta must be regarded as a great contribution to preventive medicine.

We come now to a period, which may be roughly defined as the year 1880, which ushered in the two most productive of the medical sciences, bacteriology and its twin sister, immunology. Whereas the experimental sciences of chemistry, physiology, and some aspects of experimental pathology, were already established and had made, and continued to make, valuable contributions to human welfare, bacteriology was destined to explain the causation of a series of dis-

eases known as infectious, and immunology to utilize these discoveries in the specific prevention and cure of many of them. The infectious diseases are not only important in themselves, but are recognized as indirectly the cause of many of the chronic diseases, so called, which are slower in their course, but none the less health-destroying and fatal in their outcome. The growth of bacteriology has been coincident with the filling of the ranks of our present army of laboratory workers, many of whom have been primarily concerned in advancing this science. Bacteriology owes its stable beginnings to two men, Louis Pasteur, a chemist, and Robert Koch, for a brief time a country physician and later professor of hygiene in Berlin. Immunology, the science which explains natural protection to infectious disease and utilizes this knowledge in creating such conditions artificially, we owe first after Pasteur to Metchnikoff, a Polish biologist with no exact medical training. It is characteristic of these sciences that their problems, although arising in cases of human and animal disease, have been developed, in large part, away from the bedside, under the conditions of greater accuracy and completeness afforded by the experimental reproduction of the disease in animals. Such an experimental disease may be interrupted and attentively studied in its successive stages and its course may often be followed outside the animal body under conditions of greatest clearness.

It was the great service of Pasteur, and particularly of Koch, to show that each one of an increasing number of infectious diseases is caused by a separate and identifiable type of microorganism. Such a microorganism is always found in each case of the disease in question, but in no other instance, and will give rise again to the same disease when reintroduced in a healthy animal of the same species. The first instances of infectious diseases studied, anthrax, typhoid, chicken cholera, tuberculosis, and others, were found to be due to minute plants called bacteria. Later observers have described similar infectious diseases due to equally lowly animal parasites, particularly to those known as protozoa.

Typhoid fever was one of the first of the human infectious diseases to yield the secret of its parasitic cause. The typhoid bacillus, *B. typhosus*, was first described by Carl Joseph Eberth in 1880, who found it microscopically in tissues from a patient that had died of typhoid fever. It was grown outside the body in pure culture four years later by George Gaffky. This organism was soon recognized as the cause of typhoid fever, although the final postulate necessary to prove the etiological relationship to the disease was not fulfilled until 1900, when Metchnikoff and Besredka succeeded in producing the disease experimentally with pure cultures in anthropoid apes. Of great corroborative importance in proving the causative relationship of the typhoid bacillus was its presence in the stools and urine of cases of typhoid fever, which was demonstrated in 1885. In the same year Fraenkel and Simmonds found the microorganism in the circulating blood of a case of typhoid fever, a condition which was later shown by the work of Kühnan (1897), Castellani and Schottmüller to be fairly constant during early stages of the malady. This observation not only proved finally and conclusively the etiological relation of the typhoid bacillus to typhoid fever, but led to a gradual reconstruction of our conception of the disease itself so that we have finally come to regard it primarily as a septicemia or blood infection rather than an intestinal disease *per se*, as the striking lesions in the small bowel had led us to assume.

A scientific discovery may be considered worth while if it merely gratifies intellectual curiosity and adds an apparently insignificant support to a structure, the totality of which makes for human knowledge and welfare. It is a characteristic of the medical sciences in general, and of bacteriology in particular, that the discovery of new principles has led very rapidly to practical results of the greatest significance to mankind. In no instance is this characteristic more strikingly true than in the study of typhoid fever. The study of *B. typhosus* as the single and essential cause of typhoid fever led rather rapidly to important advances in the prevention and cure of the disease.

I have already referred to the valuable suggestions of Budd and Murchison that the potential danger of contagion in typhoid fever lies in the excreta from patients. In common with all empirical results arrived at by retroactive judgment between cause and effect, these suggestions were only partly convincing and led to only partial avoidance of the danger. Witness, for example the obstinate assertion of Pettenkoffer, the great hygienist, who insisted that the contagion in this disease must pass through a ripening stage in the earth, and that its spread is dependent on the level of ground water. The demonstration that the typhoid bacillus was not only the cause of the disease, but that it is present in the stools and urine of typhoid patients, at once led to more logical and far-reaching avoidance of these sources of contagion. It was accepted not only that typhoid patients are a source of possible danger, but it was soon suggested that even after their recovery they might continue to retain the germs of the disease in their urinary bladder or intestines (Horton-Smith, 1900; Koch, 1902). This led, at Koch's suggestion, to a systematic investigation of the stools of recovered cases of typhoid fever in certain parts of Germany where the disease was particularly prevalent, and showed that four per cent. of all recovered cases remain "carriers" of *B. typhosus* for varying lengths of time, some of them for years. In connection with this study Drigalski made the important observation that a few individuals may harbor the typhoid bacillus in their intestines without ever having suffered from the disease, "healthy carriers" as they are called. Repeated observations in all parts of the world have shown that through contamination of foodstuffs, these carriers may produce not only a chronologically extended series of cases, but actual acute epidemics. The obvious remedy consists in detecting the innocent but dangerous individual and isolating or curing him.

Food contamination occurs not only in its preparation by carriers, but sometimes through transfer of the bacteria by flies, as has been shown to be the case particularly in asylums and prisons where excreta have been left exposed in the neighborhood of kitchens. Reed, Vaughan and Shakespeare have particularly emphasized this danger of fly transmission in their careful study of the devastating effect of the disease among our troops in the Spanish-American war. Evidence of this sort has led to an appreciation of the necessity of proper, protected latrines which can be rapidly built even in temporary camps.

These and other real contributions toward the prevention of the spread of typhoid fever have been made by pure bacteriology. Let us now consider what the sister science of immunology has accomplished. I have only suggested how much the demonstration of the typhoid bacillus in the blood or stools of a suspected case of typhoid may aid in diagnosis of the disease. As a matter of fact no diagnosis is complete or indeed certain without such examination. An even

simpler and almost as reliable method of laboratory diagnosis has been devised by Widal and by Gruber, depending on a principle that had been previously discovered in laboratory experiment. Bordet in particular is responsible for having shown that the blood serum of animals that have been given injections of a microorganism may be distinguished from the serum of normal animals by the fact that it clumps the microorganism in question. This fact was applied by Widal in his now famous test for typhoid fever, which depends on the presence of this agglutinating substance in the serum of those that are suffering from typhoid fever. This sign occurs in nearly all cases of the disease, although more frequently in its later stages.

Our present methods of protective vaccination against typhoid fever depend on principles that have been dimly appreciated but at times successfuly used by very primitive peoples throughout the centuries. It had been observed that those who recover from certain of the infectious diseases are thereafter protected from them. With this fact in mind the Orientals practised arm to arm inoculation with smallpox virus which usually produced only local evidence of the dread disease and was followed by protection from it. Jenner made this haphazard and dangerous method of prophylaxis a safe one by utilizing virus from a modified form of smallpox, namely cowpox, which is not only harmless, but gives equally good protection. Full understanding of the principle involved and its application to other infections, however, was dependent on the advent of bacteriology a century later. Pasteur not only separated out the causative agents of a number of diseases, but found that he could so modify their virulence that they no longer produced fatal or serious effects when reinoculated into animals. Those that had been treated with these modified germ cultures were found, however, to be protected against fully virulent original growths of the microorganism.

Facts such as these were early discovered in respect to the infections produced by the typhoid bacillus in small animals. Beumer and Peiper in 1887 found that mice that had recovered from a non-fatal dose of this organism would subsequently withstand doses that were fatal to their untreated brothers. Shortly after, following a very important discovery by two American scientists, Salmon and Smith, it was found that this same protection could be effected in animals by the previous injection of cultures of the typhoid bacillus that had actually been killed by heat.

In 1894 two German scientists, Pfeiffer and Kolle, on the basis of further theoretical studies, were led to try the effect of giving human beings small hypodermic injections of dead typhoid bacilli. They found that the doses they used produced certain uncomfortable but transitory symptoms, but that the blood of such treated individuals when subsequently examined contained antibodies which indicated that they were protected against typhoid fever. At the same time, and independently, A. E. Wright began similar inoculations in British soldiers who volunteered for the purpose. The inoculations did them no harm, and as larger and larger groups of these vaccinated men came into being and were subjected in war to the same dangers of typhoid infection as were untreated men in the same regiment, it became evident that they were much less likely to contract the disease than the uninoculated, and when such vaccinated men did at times come down with typhoid fever, the disease almost invariably ran a milder course than in the unvaccinated and the mortality among them was distinctly lower.

It took something over ten years to con-

vince the thinking world that preventive inoculation against typhoid fever is harmless and that to a striking extent it does protect. The results attained in the German and English armies and among the personnel of hospitals have assured us that these classes of people, who are the most exposed to typhoid fever, become, when vaccinated, only one half to one sixth as liable to contract the disease as the untreated. The protection, then, under these unfavorable conditions, is not absolute, but very evident. Much better results have been obtained in the last few years in the United States army, where, in spite of objection, typhoid vaccination has been made compulsory since 1910 for all men under forty-five years of age. Whereas in the preceding nine years there were on the average 351 cases of typhoid annually, since compulsory vaccination the cases have sharply diminished until in 1913 and 1914 there were only four and seven cases, respectively, a truly remarkable showing. These last results have been enough to convince the most skeptical, and have led to widespread adoption of the method, not only in armies, but in civil communities. These results in our army, life-saving, convincing and valuable as they have been, are open to a very slight objection in my opinion; they have led the public, and particularly the medical profession, to a slight over-confidence in the efficacy of the method itself. These army results are essentially perfect, at least far nearer perfection than has ever been reached by any similar type of biological preventive or curative treatment, a fact which leads us to suspect that they are exceptional and due to the operation of a set of conditions which, in spite of their existence over a considerable period of time, are not to be counted on.

Among the conditions that have operated in making these conditions more perfect is the vaccine employed and the method used in its administration. Army officials are, in my opinion, inclined to attribute an undue importance to this factor. They use a certain strain or race of the typhoid bacillus derived from England, to which they are inclined to attribute particular properties of immunization. Results elsewhere have indicated, and we believe we have strong evidence from unpublished work in our own laboratory, to prove that a vaccine compounded of a number of strains of the organism is better. The army has introduced three instead of the two injections which were formerly used in England, and this is an undoubted advance.

The fact remains, however, that the army vaccine, or at least vaccines prepared by commercial firms from the army bacillus under identical and simple conditions, do not invariably protect in civil life. Recent reports from the continental armies, each employing a different method, show that in none of them is the protection afforded nearly absolute, in spite of the fact that in parts of the French army four or five injections have been given. I am inclined to believe with Sawyer that the superior results in our army are largely due to the fact that the entire body of men has been protected, that there has been no single unprotected spot for an epidemic to get a start and gain in violence, to use a vague and perhaps not wholly accurate simile. Some recent results in France certainly indicate that antityphoid vaccination is more effective in those groups with the higher percentages of assuredly vaccinated men.

I have gone somewhat fully into this discussion of the army typhoid vaccine for the purpose of indicating that their results, although exceptional, have by no means convinced other authorities that the methods they employ are in detail the best. Let me emphasize again that we are not now

considering whether typhoid vaccination is of value, *that* you must accept as proved beyond peradventure, but just how valuable it is and in what way it may be further perfected. In other words I am leading you into those intricacies of detail which any scientific problem attentively considered must present, and from the unraveling of which new and important issues may arise.

Our former beloved professor of hygiene, George Reinhardt, came to me some three years ago and asked if I did not agree with him that the student body in this university should be offered the opportunity of being vaccinated against typhoid fever. With no hesitancy at all I answered "Yes." When he pressed me further as to the best method of preparing and administering the vaccine I felt unwilling to decide so important a matter on the basis of literary knowledge alone. In association with the late Dr. Edith J. Claypole we undertook to arrive at some conclusions on the subject. We found that nearly twenty different preparations of typhoid vaccine had been suggested, and each regarded by its author as the best. Data, however, on which to compare one vaccine with another were almost entirely lacking, that is to say a vaccine was approved because it had worked well under a given set of conditions with a more or less considerable number of men without any direct comparison with other vaccines.

Three distinct improvements in the vaccines in vogue seemed possible.

First: All vaccines were admitted to protect, at best, for only relatively short periods of time, say about two years.

Second: Many of the vaccines advocated were admitted to give rise, on administration, to rather uncomfortable transitory symptoms.

Third: The current method of administration, three injections over a period of three weeks or more, seemed an unnecessarily long period to wait for protection.

It was with these questions particularly in mind that we began our experiments. Out of them have arisen innumerable further questions, some of which have given rise to investigations of theoretical and practical interest. In the first place there had been no convincing experimental method of comparing the relative protective value of various vaccines. The only results of value seemed to be statistics from inoculated men obtainable only after years and under most uneven conditions. Certain experiments of Metchnikoff and Besredka with anthropoid apes were suggestive, but impossible to carry further, owing to the expense of these animals. We finally adopted an experimental procedure in rabbits that had been used for other purposes and which, with our modification of it, led us to conclusions that were rapidly obtained and apparently valid. It was found possible to compare several of the best typhoid vaccines in respect to the length of time they protected rabbits against infection with living typhoid bacilli. As a result of many experiments of this sort we came to the conclusion that a new type of "sensitized" vaccine, as it is called, gives rise to the most durable immunity. The word "sensitized" simply means that the bacteria in the vaccine have been treated with the serum of animals that have been highly immunized against them. It was furthermore found possible to remove certain toxic elements (endotoxins) from these vaccines with a further increase in immunizing property. The final product, then, a "sensitized vaccine sediment," as we call it, not only protects animals longer from infection than other vaccines, but is found when injected into human beings to produce little or no reaction.

Another improvement we have suggested is the administration of the customary three doses of vaccine within a week instead of the three weeks usually regarded as necessary. Here again careful experiments in rabbits showed us that this rapid method produces an equally efficient and lasting protection.

The final proof of the value of a preparation is of course in practise, that is to say, its actual protective value for human beings. The California State Board of Health has been supplying our vaccine for free distribution to physicians for the past two years. Dr. Sawyer, of this board, undertook to find out the results of typhoid vaccination in this state about a year ago. He obtained records from over 5,000 cases that had been treated with our vaccine, and something over half that number that had been treated with various other vaccines, mostly of the army type, as dispensed by commercial houses. There were about the same actual number of failures to protect in both series, that is, there were twice as many cases of typhoid fever per thousand among those vaccinated with other vaccines as with our own.

It is evident, then, from these results and from what I have said, that typhoid vaccination, at least in the general community, is relatively, but not absolutely, protective. It remains for future investigation to determine in what way the percentages of failures can be decreased.

It seemed to us very important, in our investigations, to devise a method by which the duration of protection could be determined in individual cases. It is all very well to know that on the average vaccination will protect for about two years, but what of the exceptional individual, who from sad experience we have learned is not protected even for two months? Dr. Force and I think we have a method for determining the actual presence or absence of protection in the individual at any given time. This tests consists in rubbing a small amount of material from killed typhoid bacilli on the skin. We have found that nearly all those who have had typhoid fever in the past, and who are known to be usually protected from it, react to this test with the formation of a slight reddish blush about the abrasion. Most people who have been vaccinated within the last two years also react positively. Normal people do not react. We feel justified in assuming that the presence of a positive reaction of this sort is evidence of protection. So far it has not failed us in practise, that is to say, no vaccinated person who has given a positive test has shortly thereafter had typhoid, and conversely in two vaccinated cases where the tests were negative and doubtful, respectively, the individuals have shortly thereafter contracted typhoid fever. It is too early to speak authoritatively about the absolute value of this "typhoidin test," as it is called, but at least we feel justified in urging our vaccinated students to be revaccinated when we find the test negative.

I hope I have somewhere in my remarks suggested to you that results of direct practical bearing are by no means always arrived at directly. In fact the experienced investigator comes to rely more and more on Pasteur's adage of "Chance and the Prepared Mind," and learns to seize chance happenings and turn them to his own ends. I think the evolution of a practical point out of theoretical studies may well be illustrated by some of our recent work. The efficacy of various typhoid vaccines has been tested, as already mentioned, by the ability of each to protect rabbits in a given dose for a given number of weeks against infection with a large dose of living typhoid bacilli. In unprotected animals, or in animals insufficiently protected, these injected

bacilli go on increasing in numbers, and although the animal may live for a considerable period, the typhoid organisms persist in his blood; he has become, in other words, a permanent carrier. In perfectly protected rabbits the bacilli disappear from the circulation within a few hours. It interested us to trace the method by which the bacteria disappear in the protected animals, and we found that coincidentally with the disappearance of the infecting bacteria there occurs a sharp rise in the number of white blood cells in the peripheral circulation. These white cells, leucocytes, or phagocytes, as they are called, are known through the work of Metchnikoff and others to be associated with defense of the body against invading bacteria. This leucocytic crisis, then, would seem reasonably to be associated with protection in these immunized animals. A moderate grade of leucocytosis occurs in the normal unprotected animal, but is apparently insufficient for the purpose. In tracing further the cause of the extreme grade of leucocytosis in the immunized animal, we found it to occur only under specific conditions, that is, only when typhoid bacilli are injected in typhoid immune animals, and not when typhoid bacilli are introduced in normal animals, or other bacteria in our immunized animals. It seemed reasonable, then, to think it might be due to the action of the specific immune bodies which circulate in immune animals and are known to increase phagocytosis by their action on the bacteria with which they unite and which they render more attractive to the leucocytes. This hypothesis we were able to verify by injecting bacteria that had been previously treated with typhoid-immune serum into the circulation of normal animals. The same phenomenon of specific hyperleucocytosis also occurred under these conditions.

Since this hyperleucocytosis is coincident with, and apparently the cause of, the body's ridding itself of bacteria, it seemed possible that the artificial production of it in typhoid fever might cure or beneficially affect this condition, which is so characteristically accompanied by a proliferation of bacteria in the blood stream. We tried out this possibility in our carrier rabbits, those animals in which we had produced a septicemia by injecting living typhoid bacilli. In some cases we cured these animals of their septicemia, and then after testing the harmlessness of large doses of our sensitized vaccine in rabbits and monkeys, even when injected directly into the blood stream, looked forward to a cautious adaptation of our results in cases of human typhoid fever.

It was nearly a year before we had an opportunity to try this method on human beings. In the meantime the results of other writers in essentially the same direction came to our attention, and further encouraged our hope in the proposed method. It will be necessary at this point to go back a step and consider preceding work that had been done in attempts at a specific cure in typhoid fever, that is to say, a cure attempted in full recognition of the cause of this disease, namely, the typhoid bacillus. Striking success in combating bacterial infections has been met with in certain cases by the application of one or more of three pretty definite methods. Some bacteria, like the diphtheria bacillus, produce their harmful effect in the body by the liberation of poisonous substances known as toxins. In the case mentioned, the disease, when taken in time, can be cured in a really miraculous manner by injecting diphtheria antitoxin, which is simply the serum of horses that have been treated with repeated doses of diphtheria toxin and thereby made to produce antitoxins that neutralize the toxin. Other diseases produce their harmful results largely by multiplication of the

invading microorganism. Such diseases, for example, as epidemic meningitis, can be cured by inoculating serum from animals immunized against its causative agent, the meningococcus. Still other diseases, principally local affections, as, for example, carbuncles, may be treated with considerable success by injecting the causative agent itself; in the example mentioned, staphylococcus. This latter form of treatment, or vaccine therapy, as it is called, builds up an active immunity and leads the animal so to muster his reactive, protecting, forces as to expel the invader.

It is this latter method of vaccine therapy which alone has been used with any success in the treatment of typhoid fever. I have already referred to the hopelessness of affecting the course of typhoid fever in any but a palliative way by the other methods of treatment that have been suggested; the fever may be favorably influenced by the continued use of cold baths, but the duration of the disease is little, if at all, affected by such means. In 1893 Fraenkel began the use of small doses of killed typhoid bacilli injected hypodermically in typhoid fever. For twenty years this treatment has been tried with varying success by many physicians, some of whom have published their results. These results, although at times encouraging, have never convinced the medical world that the method is strikingly successful. The best that may be said of it is that it does no harm, and in the hands of some physicians apparently shortens the disease and prevents some of the unpleasant sequels by which typhoid is so apt to be followed.

During the past two years two innovations have been made which, from the results attained by several observers, and in view of the theoretical studies on hyperleucocytosis to which I made reference, have thrown an entirely new light on the possibilities of vaccine therapy in typhoid fever. These two innovations are, briefly, as follows: First, the administration of the vaccine directly into the circulation, and secondly, the use of a sensitized or serum-treated vaccine instead of the plain bacterial growth hitherto used. These procedures, introduced into practise by Thiroloix and Bardon, and by Ichikawa, respectively, carried out the precise method of treatment that we had already suggested from our experimental results, and fully justified our expectations.

During the past year it has been possible for us to carry out the intended treatment in a number of cases in this vicinity, through the great courtesy of physicians who have allowed us to see their patients and have been willing to accept our suggestions in relation to their treatment. This confidence and cooperation has resulted not only in rapid amelioration in the majority of cases, but through comparative study of the successful with the unsuccessful cases has suggested improvements which may increase the percentage of favorable results.

Let us consider what happens when a killed preparation of sensitized typhoid bacilli is given intravenously in a case of typhoid fever. The introduction of something like one twenty-fifth of a milligram of the vaccine into the circulation is followed in a few minutes by a distinct shaking chill, which is accompanied by a rise of the fever of from one to two degrees. This shaking and fever, which is seldom extreme enough to be very uncomfortable, is accompanied by a fall in the number of white blood corpuscles. Following this reaction the fever rapidly falls so that in from six to twelve hours the temperature has reached normal, or even subnormal. This fall in the fever is accompanied by a rise in the leucocytes, profuse sweating, and a feeling of well-being. The severe headaches, begin-

ning delirium, and other symptoms characteristic of typhoid, disappear, or are markedly ameliorated. Perhaps the most important result produced is that the blood usually becomes free from bacteria following a single injection. In forty per cent. of the cases, this return of temperature to normal is permanent, and the patient remains symptomatically, and to all intents and purposes, well. The temperature may fluctuate for a day or two and then become normal. This forty per cent. of aborted cases, as we call them, actually about twenty-five in our series, were restored to a permanent normal condition within a week after beginning treatment. About twenty-five per cent. more are markedly bettered, but not so rapidly cured; the course of these ameliorated cases is characterized by a permanent drop of say a degree in temperature following each injection, and the average duration of the disease in this category is distinctly shorter than is usual. There remain, however, a third of our cases, which total sixty-two, in which the intravenous vaccine treatment has produced no demonstrable effect. These cases are usually severe ones from the onset and it is impossible to say that the treatment did not prevent an even more serious course than the one observed. At least it may be said that the treatment does no harm in these cases, and is followed by temporary abatements of fever and symptomatic benefit. There is a significant blood picture in this class of unaffected cases; they are found to differ from those that are benefited by the treatment in the weakness of antibodies present in the serum. Mention has already been made as to the occurrence and diagnostic value of certain of these antibodies or agglutinins in typhoid fever. We believe from our study that a certain concentration of these antibodies is necessary to assure recovery or benefit after the vaccine injection which, as has been mentioned, produces an increase in the leucocytes. Our present conception of the mechanism of the rapid cure that is frequently produced is that it is due to the combination of these two factors, increased leucocytes and antibodies already present in the body. In other words, when the patient is fighting the infection successfully, a sudden call on his reserves, the phagocytes, finally routs the invader. It may be possible to supply these antibodies when they are lacking by serum from immune animals, and this is one of the many problems connected with this disease on which we are now engaged.

I have tried to lead you into full view of the firing-line of the forces attacking typhoid fever. You will perceive that much remains to be done in the line both of prevention and of cure, but you will not fail, I am sure, to share my belief that here is one of the major diseases which will eventually disappear. I have endeavored to show you the vulnerable points in its cycle of development. If individual cases be rapidly cured, much suffering and death will be prevented and great economic loss avoided; the period of dissemination of the disease germs will also be greatly shortened. Again, if comprehensive sanitary regulations safeguard the disposal of excreta from typhoid fever cases, detect and eliminate the carrier, and prevent the contamination of food and drink, the continuity of the disease will also be interrupted. Thorough prophylactic immunization of large or entire communities will not only protect most of the vaccinated individuals, but prevent foci for further spread of the disease.

You will appreciate the inequality in the utilizable knowledge of typhoid fever that has been acquired through the two different types of medical advance. The purely observational, bedside, clinical progress, resulted, after the lapse of centuries, in cri-

teria on which a differential diagnosis could be made with considerable accuracy; in certain observations from which not wholly convincing conclusions were drawn as to the spread of the disease, and certain methods of palliative symptomatic treatment like hydrotherapy, and more recently, increased feeding. Contrast with this the advances during the last thirty-five years, which marks the era of bacteriology. The parasitic cause of the disease was determined. The demonstration of this microorganism gave us a means of certain diagnosis of the disease; threw light on the nature of the disease process itself; conclusively settled its method of spreading; and has given the only efficient means for specific prevention and therapy.

You will be convinced from this example that advances in applied medicine lie through laboratory investigation rather than through observations made at the bedside, at least in so far as the infectious or parasitic diseases are concerned. Equally persuasive data, from the laboratory standpoint, could be given in relation to the diseases of disturbed metabolism which involve the sciences of chemistry and physiology. You will further readily believe from the complexities of this one problem that I have tried to suggest, that successful prosecution of work of this sort may well monopolize the attention of a large group of workers. The number of these workers is limited only by the opportunities that are available; a reserve supply of eager and potentially productive minds is always at hand. The work itself is, however, not self-supporting, such advances as we may be able to make in the prevention and cure of disease bringing no pecuniary reward. It is fortunate indeed for our welfare that the contributions to human health are not patented as are contributions to human comfort and luxury.

The opportunities for advances in the medical sciences come, in part through private benefaction, in part through public funds wisely administered, when, as in this university, opportunities are given not only for the dissemination of acquired knowledge, but also for its advancement. This ulitization of public funds for any particular research is justified, apart from any preconceived notion as to its promise of practical reward.

Frederick P. Gay
University of California

CHARLES WILLARD HAYES

The geologist, geographer and explorer, known to colleagues and friends as "Willard" Hayes, died, after a long illness, at his home in Cleveland Park, Washington, D. C., February 8, 1916. He was fifty-seven years old, and in the twenty-eighth year of his professional career.

Hayes was born at Granville, Ohio, graduated at Oberlin (A.B.) 1883, and received his doctor's degree at Johns Hopkins University in 1887. His entry, in the same year, to the scientific staff of the U. S. Geological Survey was, as with most young men joining scientific bureaus of the government, a continuance of the student and research life. Hayes's studies were destined to contribute to a fuller understanding of the principles of geology and physiography; to better the methods of geological investigation and to make more practical, as well as more comprehensive and thorough, the application of geology to economic problems.

The first assignment of Hayes was as assistant to Russell, who, under the direction of Gilbert, then chief geologist, was making a general geologic section across the southern Appalachians. After a year of apprenticeship Hayes succeeded Russell, and began the areal geologic mapping, which he had satisfied himself was the only way to solve the complex structure of this region. It was in the course of this work that he demonstrated, in the folded strata, the existence of flat overthrust faults some of which have a horizontal dis-

placement of several miles, and proved that they are characteristic and essential features of Appalachian structure where the thrust was concentrated on a single fold. The discovery of these faults, the importance of which was first recognized by Hayes, and their coincident mapping in another area by Keith, with subsequent fuller elaboration by Keith, Willis and Campbell, established what may, in effect, be regarded as a geologic principle that has influenced the interpretation of geologic structures in many other parts of North America.

Meanwhile modern physiography, largely an American product, which was then being organized and made a science by Powell, Gilbert, Russell and Davis, found an enthusiastic disciple in Hayes, who, with Campbell, began to apply the principles of the new science in the interpretation of the surface features of the field in which he was at work. Their first paper, "Geomorphology of the Southern Appalachians," published in the *National Geographic Magazine*, is regarded generally as the standard work on the physiography of the region covered, and as having laid a broader foundation for physiographic investigation in general.

In 1891, Hayes participated as geologist in an Alaska expedition by Lieut. Frederick Schwatka, during which a region between the Yukon and Copper Rivers, not previously seen by white men, was traversed with topographic sketching and observations on the geology, geography and mineral resources. Some results of this, at that time very difficult exploration, including data on the northern limit of Pleistocene glaciation in Alaska, on recent volcanic activity, and on the distribution of gold and copper in the region, were contributed in the *National Geographic Magazine* for that year. To the insight then gained by Hayes of the possibilities of mineral wealth in Alaska which then was little known, was due, in no small part, the organization, later, by the Geological Survey of the systematic investigation of the geology and mineral resources of Alaska.

As Hayes became more strongly identified in the economic work of the Geological Survey, more attention was given by it to the systematic investigation of the non-metalliferous and the fuel mineral resources of the country. As a result of his special interest and personal accomplishments in this department of the survey activities, he was, in 1899, placed in charge of the newly established Section of Non-metalliferous Resources. In 1902, he was made chief geologist of the survey, in which position he continued until his resignation in 1911.

At the request of the military governor of Cuba, Hayes was, in March of 1900, detailed to make a reconnaissance of the economic geology of that island. The principal results of his observations on the island, supplemented by those of his assistants, T. Wayland Vaughan and A. C. Spencer, were contributed in a report to General Wood.

In response to a request from the State Department, Hayes was, in 1907, detailed to make a geological investigation in Nicaragua and Costa Rica, primarily for the advice of the Nicaragua Canal Commission. Some accounts of this work, which occupied also a part of the following year, were embodied in several papers, chief among which is his report to Admiral Walker, president of the commission, on the "Geology and physiography of a region adjacent to the proposed Nicaragua canal." This is a principal source of information as to the geology of that part of Central America.

On account of the interest taken by citizens of the United States in the important discoveries of oil in Mexico, and of the apprehension as to the effects of these discoveries upon the oil industry of this country, Hayes, in company with David T. Day, was, in 1909, selected to visit the new developments in the southern republic. Following his return to this country, a report was transmitted to the President, a summary of which appeared as a Senate Document (No. 79), stating that the Mexican oils were of fuel grade, being inferior to most of the American oils, and that their principal markets were likely to be found in Mexico itself and in other foreign countries.

In 1910, Hayes was, by request of the War Department, sent to Panama to procure data

relating to the geologic conditions in the Canal Zone and, especially, in the Culebra Cut. A report by him on the causes of the landslides and other failures in the sides of the cut, and of means for their prevention, submitted to the Secretary of War, was, in summary form, included in the President's message to Congress. Hayes's recommendation, which led to the appointment of a geologist to serve regularly with the Canal Commission, was a wise provision and it would appear to be no fault of these geologists that some of the subsequent disasters were not averted.

In 1901, Hayes began the study of the problems of oil and gas geology, his first investigations being in the Coastal Plain of Texas and Louisiana. Largely as a result of this work, and the growing appreciation of the enormous value of the study of geologic structure in the search for oil and gas, Hayes's services were persistently sought by private interests engaged in the development of oil pools. Finally, in recognition of his ability in oil geology and his success in the Geological Survey as organizer and administrator, he was irresistibly solicited to become vice-president and manager of the "Compania Mexicana de Petroleo 'El Aguila,'" a position which, in October, 1911, he resigned from the survey to accept and which he held until the time of his death. In the new service, he recruited a staff of young geologists, with which he was able, with most brilliant economic results, to accomplish, in effect, a geological reconnaissance of about one half of the Province of Vera Cruz, before the abandonment by the United States of Tampico and Vera Cruz, combined with illness and other circumstances, made it necessary for him to leave Mexico and his work unfinished. From this illness he never recovered.

During his career of twenty-four years in the U. S. Geological Survey, Hayes's geologic work, whether as assistant or as chief geologist, was comprehensive, original, efficient and constructive. He examined in detail and mapped the geology of sixteen quadrangles in the southern Appalachian region, for nine of which the results were published in folios of the Geologic Atlas. He made examinations of non-metalliferous deposits, iron ores, and features of geologic importance in many parts of the country. He was the author, alone or in conjunction with other geologists, of seven papers, published in the annual reports, and of thirteen in bulletins of the Geological Survey. A large number of papers were printed in the publications of various learned and professional societies of which he was a hard-working, helpful and productive member. In 1908 the honorary degree of LL.D. was conferred on him by Oberlin.

It was a privilege to be associated with Hayes. With a master mind, he was genial, philosophical and stimulating. With a penetrative insight of men and things, he sympathetically encouraged, steadied, strengthened and put on a higher level the work of his assistants, while to his colleagues he gave friendly criticism, wise counsel, and unstinted and unselfish assistance.

DAVID WHITE

A SCHOOL OF NURSING AND HEALTH AT THE UNIVERSITY OF CINCINNATI

THE University of Cincinnati has taken over the school of nursing and health of the Cincinnati General Hospital and has put it under the immediate direction of the dean and faculty of its college of medicine. The university has already been given control of the laboratories of the hospital and, through its medical faculty, of doing all the medical, surgical and research work at the hospital. Appreciating the service rendered to the people of Cincinnati by the medical faculty, the city authorities requested the university to undertake the direction of the school of nursing and health also. The university will thus be responsible for all of the educational and scientific work of the entire hospital and its various branches. When the new medical college building is completed, as it is expected it will be early next year, the work of the medical college, the pathologic institute and the school of nursing and health will be assembled in one place, as they already are in one organization.

Nursing will become a skilled and learned

profession to a degree far beyond its present attainment. The advance of modern scientific methods of treating the ills of mankind has already forced the issue upon medical training. That inadequate preparation of nurses and exploitation of them by so-called training schools will be eliminated is an inevitable next step. A nurse should have a liberal, broad education in language, history and the social and physical sciences; and she, like the physician and dentist, should keep up with developments in her own and allied professions. Carried out in this way nursing becomes a dignified calling demanding for success a comprehensive university training.

The school of nursing and health is to be made a high-grade institution, not only for training nurses, but for preparing women to do sanitary and social work in both town and country. It will have three kinds of courses and students.

1. A three-year course for nurses, including systematic instruction and cooperative work in the hospital. This course will lead to a diploma in nursing.

2. A five-year course leading to a degree, including two years of study in the fundamental sciences in the university. This is planned to train a higher class of institutional officers, teachers and sanitarians.

3. Special courses for graduate nurses from other hospitals and schools.

The usual preparation demanded of all incoming students will be required for admission to the first two courses. A certificate from a recognized hospital or school will admit to the special courses.

The staff of instructors has been selected, which will be aided by the professors in the medical college. The director of the school is Miss Laura Logan, a graduate of Acadia College and of Columbia University and formerly of the Mt. Sinai Hospital, New York City. Fourteen instructors constitute the present faculty of the school, not including the members of the medical and other university faculties who give the instruction in chemistry, biology, anatomy, physiology, economics, sociology and general subjects. A noteworthy feature is the appointment of a trained psychologist to give instruction in a subject recognized more and more as invaluable to the physician and nurse.

More and more the university is offering opportunities for the higher education of women, following the educational policy of President Dabney. In 1905 the college for teachers was launched, and in 1914 the school of household arts was made a department of the university. The school of nursing and health is therefore a consistent development.

PRACTICAL WORK FOR STUDENTS OF THE NEW YORK STATE COLLEGE OF FORESTRY

THE forty-three juniors of the State College of Forestry at Syracuse, who have five months between their junior and senior years for practical work, are scattered literally to the four corners of the continent in all fields of forestry work. It is the policy of the college of forestry to give its students the maximum amount of sound, practical training in their four-year course. Too often college students waste their summer vacations. At the end of the freshman year the boys are helped to get into practical work with lumber companies, landscape concerns and wherever there are openings for hard work with experience. The entire sophomore summer of three months is spent in camp on Cranberry Lake. This camp is as much a part of the four-year course as the mathematics or chemistry taught in the college. The junior year then closes on May 1 and the senior year does not open until October 1, giving the juniors five months for practical work along forestry lines. Many of the boys in the college of forestry are earning their own way and this period of five months not only gives them opportunity for securing a lot of valuable experience but it means sufficient funds for carrying them through their final year in college.

Practically every one of the juniors in the college of forestry is working during this summer vacation in some phase of forestry. Eight of them are with the United States Forest Service on national forests, both in the east and the west. These fellows will be engaged on look-out work to detect forest fires, in the

construction of roads, trails and bridges, in forest reconnaisance and mapping, and in other phases of national forest activities.

Seven of the juniors are working with lumber and wood-preserving companies, eight are engaged in landscape forestry and five others in consulting forestry work. In addition two are engaged in city forestry work in New York and the other eleven men are in the state forestry work, in forestry work for themselves or in attending the sophomore forest camp in the Adirondacks. Most of the men are working in New York state in some phase of practical forestry work, although the school has become national in its activities inasmuch as it draws students from practically all of the states of the union. Its graduates and the juniors who are seeking temporary work only have so far had opportunities to engage in work all over the country, although it is probable that the largest number will remain in this state.

This season the boys who have gone out from the college of forestry for work have secured positions paying from $40 to $100 per month and expenses. Many of the temporary positions lead to permanent work upon graduation from the college. Many calls have come to the college for men and it has been impossible to send them out owing to not having men with a sufficient amount of training. This situation is evidence of a growing interest in forestry and proves that more men will be needed in the future for the protection of our great forest areas and in the development of the industries dependent upon the forests.

STANFORD UNIVERSITY ARBORETUM

The Stanford Arboretum, comprising approximately 200 acres, and established by Senator Stanford in 1882, has been placed under the control of the department of botany with a view of more fully utilizing it for scientific purposes. An annual appropriation is to be made for the acquisition of specimens, that for the current year being $1,000.

The original collections, which will form the nucleus of the new plantings, contain several hundred species, representing about sixty families. The collection of conifers is especially rich in genera. Including both the Taxaceæ and Pinaceæ, this group of plants is represented by nineteen genera.

As the climate at Stanford is warm enough in winter for orange and lemon trees and cool enough in summer to successfully grow the white pine and Norway spruce, it should be possible to grow almost any species of the temperate and subtropical zones. Plants from Australia, New Zealand, Chili, South Africa and the Mediterranean region are well adapted and will thrive without being watered during the dry season. With such excellent natural conditions the Arboretum should become eventually one of the most extensive collections of arboreal plants. A feature that is to be given especial attention is the West American section. In a tract, set aside for this purpose, it is planned to bring together as complete a collection as possible of the native trees and shrubs of the Pacific coast, Great Britain, Rocky Mountains and the arid southwest.

The development of the Stanford Arboretum along broad scientific lines is meeting with enthusiastic approval and support. Among those who have taken interest in its establishment and offered to contribute toward the building up of the collections are: Dr. C. S. Sargent, director of the Arnold Arboretum of Harvard University; Dr. N. L. Britton, director of the New York Botanical Garden, and Dr. David Fairchild, in charge of foreign seed and plant introduction, United States Department of Agriculture. Mr. H. A. Greene, president of the Monterey Tree Growing Club, has presented already nearly 200 species, many of which are rare and impossible to obtain through ordinary trade channels.

Mr. John McLaren, superintendent of Golden Gate Park, has taken an active interest and has consented to assist in the general planning, especially along the principal avenues. Mr. McLaren's success with the landscape gardening in Golden Gate Park and at the Panama-Pacific Exposition assures the Arboretum the very best advice for its landscape architecture.

Coincident with the new policy of the Arboretum the university has set aside several tracts

on the Palo Alto estate for the preservation of the native vegetation. These plant reserves embrace several hundred acres and contain a variety of plant formation, such as streambank, redwood cañon, oak-madroña forest, serpentine outcrops and chaparral. In a preliminary survey of the reserves 64 species of native lignescent plants were catalogued.

SCIENTIFIC NOTES AND NEWS

SIR WILLIAM RAMSAY, the distinguished British chemist, died on July 23, in his sixty-fifth year.

AT the annual meeting of the Royal Society of Arts on June 29, two weeks before the death of Elie Metchnikoff, it was announced that the Albert medal of the society for the current year had been awarded to him "in recognition of the value of his investigations into the causes of immunity in infective diseases, which have led to important changes in medical practise, and to the establishment of principles certain to have a most beneficial influence on the improvement of public health."

THE Royal Society of Edinburgh at its meeting of July 3, elected foreign honorary fellows as follows: Professor C. Barrois, professor of geology and mineralogy, Lille; Professor D. H. Campbell, professor of botany, Leland Stanford University; Professor M. E. Gley, professor of physiology, Paris; Professor C. Golgi, professor of anatomy, Rome; General W. C. Gorgas, U. S. Army; Professor G. B. Grassi, professor of comparative anatomy, Rome; Professor E. C. Pickering, director of Harvard College Observatory; Professor E. Warming, emeritus professor of botany and keeper of the Royal Botanic Gardens, Copenhagen.

SIR GEORGE T. BEILBY, F.R.S., the chemist and metallurgist, Mr. Edward Dent, Sir Robert Hadfield, F.R.S., the metallurgist, and Sir H. Capel Holden, F.R.S., the electrical engineer, have been elected to the council of the Royal Society of Arts.

THE Earl of Selborne has resigned the office of president of the British Board of Agriculture and Fisheries.

THE prize fellowship, offered by the English Federation of University Women to encourage research, has been awarded to Dr. Alice Lee, fellow of University College, London, who proposes to undertake an investigation into the birth-rate as affected by present conditions.

DR. VICTOR V. ANDERSON has been placed in charge of a medical department and psychological laboratory in the Boston police court established by the city council on June 23.

DR. WILLIAM S. O'NEILL SHERMAN, Pittsburgh, has started for Europe, where he will do research work in war hospitals for the Rockefeller Institute. He is to make a special study of gangrene, tetanus and amputation.

THE Department of Botanical Research of the Carnegie Institution of Washington will be represented at the sixty-eighth meeting of the American Association by Drs. Forrest Shreve and H. A. Spoehr.

ZOOLOGICAL investigations are being conducted this summer by the department of forest zoology of the New York State College of Forestry at Syracuse, on the following lines: The fish survey of Oneida Lake is being continued by Dr. C. C. Adams and Professor T. L. Hankinson, assisted by Mr. A. G. Whitney. Mr. Frank C. Baker is continuing his study of the relation of molluscs to fish. Professor H. N. Jones, bacteriologist of Syracuse University, is studying the diseases of fish. Professor P. S. Welch, of the Kansas State College, is working in cooperation on the annelid worm fauna of the lake and on the fish food in the water lily zone. Through a grant by Hon. R. M. Barnes, of Lacon, Ill., also cooperating with the college, P. M. Silloway is making a survey of the bird life in the forests about the Summer Forest Camp at Cranberry Lake, Wanakena, N. Y.

THE Board of Scientific Directors of the Rockefeller Institute for Medical Research announce the following promotions and appointments: Dr. Alphonse R. Dochez, hitherto an associate in medicine, has been made an associate member. Dr. Henry T. Chickering

has been appointed resident physician in the hospital to succeed Dr. Dochez. The following have been made associates: Dr. Louise Pearce, pathology and bacteriology; Dr. Frederick L. Gates, pathology and bacteriology. The following have been made assistants: Dr. Oswald Robertson, pathology and bacteriology; Ernest Wildman, chemistry. The following new appointments have been made: Dr. Rhoda Erdmann, associate in the department of animal pathology; Dr. Rufus A. Morrison, assistant in medicine and assistant resident physician; Dr. John Northrop, assistant in the department of experimental biology; Dr. Jean Oliver, assistant in the department of pathology and bacteriology; Dr. Ernest W. Smillie, fellow in the department of animal pathology; Dr. William D. Witherbee, assistant. Dr. Hardolph Wasteneys, hitherto an associate in the department of experimental biology, has, as has already been noted in SCIENCE, accepted an appointment as associate professor of pharmacology in the University of California.

UNDER the auspices of the Botanical Seminar of the Michigan Agricultural College, Dr. William Crocker, of the University of Chicago, gave a public address recently on the "History of Our Present Knowledge of Plant Nutrition."

AT the sixty-fourth annual meeting of the Maine Medical Association, held in Portland, an illustrated lecture on "Experiences of the Layman on a Journey of Three Months in Japan, Korea and China with Three Prominent Medical Men" was delivered by Dr. Wallace Butterick, secretary of the General Education Board of the Rockefeller Foundation.

MR. LEONARD DARWIN gave the presidential address at the annual meeting of the Eugenics Education Society held in London on July 6.

CHARLES WILLIAM HENRY KIRCHOFF, a past-president of the American Institute of Mining Engineers and for many years editor of *The Iron Age,* died on July 23, at the age of sixty-three years.

SIR VICTOR HORSLEY, the distinguished English surgeon, neurologist and author, died on July 16, at the age of fifty-nine years, at Amara, in Mesopotamia, from a sun stroke.

THE death is announced of Prince Boris Galitzin, professor of physics in the Imperial Academy of Sciences, Petrograd, known especially for his work in seismology.

GASTON MASPERO, the well-known Egyptologist, permanent secretary of the Académie des Inscriptions et Belles-Lettres, Paris, died on June 30.

THE twenty-seventh annual meeting of the British Museums Association was held at Ipswich on July 11 and 12, under the presidency of Mr. E. Rimbault Dibdin, curator of the Walker Art Gallery, Liverpool.

SIR WILLIAM OSLER has sent word to a number of American surgeons that there are vacancies for 120 young American medical graduates in the military hospitals of London and its immediate neighborhood. The term of service is six months. There will be a small salary and passage will be paid both ways.

AN isolation hospital having a capacity of forty beds is being erected in connection with the State University of Iowa, College of Medicine. It is reported that $42,000 has been set aside for the construction of the institution.

THE United States Coast and Geodetic Survey vessel *Surveyor,* was launched at Manitowoc, Wis., on July 22. It is a steel steamer of about 1,000 tons displacement, with triple expansion engines, and will use crude oil for fuel. Sixty-six officers and men can be accommodated. The vessel can carry enough fuel and stores to remain at sea for three months. The *Surveyor* is held to be the most modern type of vessel ever built for surveying purposes, and will be used for work on the Pacific coast and Alaska. It is intended that she shall be finished this fall in time to leave the Great Lakes before the close of navigation. Miss Elizabeth Brent Jones, daughter of the superintendent of the Coast and Geodetic Survey, named the vessel.

THE results of a large number of recent physical tests of road-building rock have been published by the U. S. Department of Agri-

culture as a professional paper, Bulletin 370. These tests have been made by the Office of Public Roads and Rural Engineering to give highway engineers information in regard to the various physical properties of the different rocks most frequently used in road construction. The three most important of these properties are defined in the bulletin as *hardness,* or the resistance which the rock offers to the displacement of its surface particles by abrasion; *toughness,* or the resistance which it offers to fracture under impact; and *binding power,* or the ability which the dust from the rock possesses, or develops by contact with water, of binding the large rock fragments together.

A POSTAL vote was recently taken of the members of the British Institution of Electrical Engineers on the proposed exclusion of alien enemies, and the details of the result were as follows: Cards issued, 3,244; cards returned, 1,470. In favor of (*a*) to expel members who are subjects of enemy-countries or states, 1,320, against, 88; in favor of (*b*) to expel members who, being naturalized British subjects, have retained enemy nationality, 1,307, against, 79; in favor of (*c*) not to expel members who are naturalized British subjects and were formerly subjects of a country or state now at war with Great Britain and Ireland, but who have under the laws of such country or state definitely lost their alien nationality, provided they are able to prove this to the complete satisfaction of the council, 1,081, against, 264; in favor of (*d*) that no person shall after the —— of ———— 19—, be eligible for election as a member of the Institution who is a subject of any country or state with which the United Kingdom of Great Britain and Ireland is or shall have been at war on or after the date mentioned, 1,120, against, 200.

ONE of the provisions of the federal aid road bill, which was signed by the President on July 11, appropriates $1,000,000 a year for ten years to be spent by the Secretary of Agriculture for the construction and maintenance of roads and trails within or partly within the national forests. The bill provides that, upon request of the proper officers of the states or counties, the money shall be used for building roads and trails which are necessary for the use and development of resources upon which communities within or near the national forests are dependent. The work is to be done in cooperation with the various states and counties. Not more than 10 per cent. of the value of the timber and forage resources of the national forests within the respective county or counties in which the roads or trails will be constructed may be spent. Provision is made for the return of the money to the Treasury by applying 10 per cent. of the annual receipts of the national forests in the state or county until the amount advanced is covered. Officers in charge say that the bill will make possible the construction of many roads which are greatly needed. Since 1913 ten per cent. of the receipts of the national forests have been used in road and trail building, but the funds have been inadequate to meet the needs. Many isolated communities within the national forests are entirely dependent on the government roads and trails. In some instances these settlements are said to be almost entirely without means of communication. According to Forest Service officials the money now made available will permit the construction of many roads necessary to open up inaccessible territory, and will greatly facilitate the development of large areas. It is said that detailed plans covering the policy to be followed in building roads are now being made.

UNIVERSITY AND EDUCATIONAL NEWS

THE jury in the Surrogates' Court of New York City has declared invalid the will of Amos F. Eno, according to which Columbia University was made the residuary legatee and would receive an amount estimated at over four million dollars. It is understood that Columbia University will seek to obtain a new trial.

THE merger of the medical school of the University of Pennsylvania and the Jefferson Medical College will not be consummated this year. The following statement was made by

a dean of one of the institutions: The members of the United Medical Committee, in charge of the medical school of the University of Pennsylvania and the Jefferson Medical College, of Philadelphia, have agreed that it is advisable to postpone the consummation of the union agreed on by the plan adopted by the trustees of the two institutions, in order that further opportunity may be afforded for considering a number of important matters relative to the mode of administration of the new school, and have, therefore, determined that each of the schools shall conduct, separately from and independently of the other and of the United Medical Committee, the work of its college term for 1916–17.

PROFESSOR WALTER S. HUNTER, of the University of Texas, has been appointed professor of psychology in the University of Kansas, to fill the vacancy caused by the removal of Professor Robert M. Ogden to Cornell University.

AT Indiana University, Professor W. N. Logan, director of the school of general science in the Mississippi Agricultural and Mechanical College, has been appointed associate professor of economic geology; and Mr. C. A. Malott has been appointed instructor in physiography and geology. Dr. J. J. Galloway, instructor in paleontology, has accepted a position as curator of paleontology at Columbia University.

HARRISON R. HUNT, Ph.D. (Harvard, '16), has been appointed instructor in zoology in West Virginia University. He takes the place of J. Theron Illick, who will sail for China in the autumn to accept a teaching position there.

AT the Michigan Agricultural College, Mr. G. R. Johnstone has resigned his instructorship in botany which he has held for three years, in order to prosecute his studies further. The vacancy has been filled by the appointment of Mr. H. C. Young, who was at the Missouri Botanical Garden last year.

WE learn from *Nature* that the Manchester City Council (governing body of the Manchester School of Technology) has established a new subdepartment of the school of postgraduate study and research in coal-tar products and dyestuffs, and has appointed Professor A. G. Green, F.R.S., to take charge of it. Professor Green recently resigned the chair of tinctorial chemistry at Leeds University in order to direct the research department of a firm of dyestuff manufacturers. His subdepartment will be under the general direction of Professor Knecht, who is head of the department of applied chemistry, and is expert in the use of dyestuffs, as Professor Green is expert in their manufacture.

IT is announced in the London *Times* that Dr. A. E. Evans, lecturer in chemistry in University College, Reading, has been placed in charge of a new department of the Huddersfield Technical College for special study and research in coal-tar color chemistry. It is expected that a number of scholarships will be tenable in the department. The directors of British Dyes (Limited) are supporting the scheme, and are prepared to contribute substantially towards its institution. At Leeds University there is already a department of color chemistry and dyeing, the endowment of which was provided by the Clothworkers' Company.

DISCUSSION AND CORRESPONDENCE

AN ENGINEER'S IDEA OF ENERGY

TO THE EDITOR OF SCIENCE: In a recent number of SCIENCE[1] Professor Kent takes exception to some criticisms of mine on the "current definition of energy." In his opening sentences he states that in seeking "some language in which to convey to students an engineer's idea of energy" he wrote: "Energy, or stored work, is the capacity for performing work" and proceeded to extend and illustrate his definition.

Now if he had only "stuck to his idea" and prefaced his statement in his book with the words he here uses in his above explanation, so that his statement would have read: "An engineer's idea of energy, or stored work, is the capacity for performing work, etc.," no one could have taken exception to his statement. It would have been *true* and, except by other engineers, not open to dispute. But when he

[1] June 9, 1916, p. 820.

assumes that his statement is a generalized one and offers it as a "definition" of energy and not as a mere statement of the meaning he wishes to have attached to a term, he lays himself open to criticism. For it *is not true* as a general definition. The quoted statement from Maxwell to which I gave my approval, but which he condemns, shows a Maxwellian conception of energy. Professor Kent, himself, shows the futility of attempting to throw the Maxwellian conception into the form of a "definition." Professor Kent rejects the idea, or conception, of Maxwell because he can not throw it into the form of a "definition"; on the contrary, I reject the "definition" because it does not in any adequate way represent Maxwell's conception. Professor Kent seems to think that the statement which I quoted from Maxwell and which met my approval does not rise to the dignity of a conception because it does not fit his (Kent's) definition.

Further on, referring to matter and energy, Professor Kent declares:

But there is a necessity for definitions of both these terms. The users of my book demand them.

The *naïveté* of this statement is delightful. I thought I was discussing a question of science and logic; Professor Kent seems to consider it one of "commerce and finance." However, in the opening paragraph, above, I have shown how he can "define" to his heart's content by merely specifically stating that such and such are the meanings that he wishes to have attached to the terms he uses and then use them consistently himself. When, however, he invades the fields of science and logic he must expect to be judged by the canons that hold in those fields. That is to say, other writers also use the terms matter and energy, but in a more general sense than is customary, or necessary, with the engineer. Professor Kent can not justly deny to others (Maxwell, for instance) a freedom which he claims for himself. It thus happens, of course, that different writers may use the same term in different senses, but that is a small thing compared to what happens when one and the same writer uses a term in two or more senses without perceiving that he is "mixing things up." It was not "definitions" *per se* to which I was objecting in my former communication, but to lop-sided, inadequate, or misleading statements intended as definitions, but which can result only in confusion and contradictions. Every writer is, and should be, free to "define" all the terms he pleases, provided only that so long as he continues to use a term he uses it consistently. Then the "survival of the fittest" will ultimately decide whether they survive or perish.

As regards the term "energy," in addition to its figurative meaning in literature it has developed two distinct technical meanings, the engineer's and the physicist's. This would not cause any great difficulty if the two technical meanings were distinctly recognized and indicated as is done with the "pound" in use as a unit in engineering practise. Professor Kent claims priority of use for the engineer's definition of energy. Granted, but priority in use can not justify a claim that the thing which he defines is the same thing as that which the physicist claims is conserved. Such a claim is exactly what I meant when I spoke of "mixing things up," or using the same term for two distinctly different things without recognizing that they *were* different. That Professor Kent's definition is consistent with the doctrine of the conservation of energy can not be admitted for a moment by any one who comprehends the meaning of the term conservation. "The capacity for performing work" *always* diminishes with the doing of work, for it *always* depends upon some existing differences, such as difference in temperature, difference in pressure, difference of level, difference in direction of motion, difference in direction of stresses, or even difference in molecular distribution as in the osmotic cell, which difference disappears when the possible work due to it is done. (Compare with Nernst's law.) The capacity for doing work may disappear entirely without diminishing the total energy of a system one particle. Hence, to claim that the capacity for doing work is conserved is tantamount to claiming that a perpetual motion machine is possible;

and the denial of such a possibility is a fundamental postulate of many writers on thermodynamics. The following statement of the postulate[2] may serve to bring out the significance of the differences referred to above:

No engine of any kind can by any means be made to maintain continuously or restore and maintain when changed, the state of the system which initially set it in motion; and the difference in the energy state which initially established the motion will disappear the more quickly the greater the activity of the engine.

In reply to Professor Dadourian's objection in Science,[3] I would call his attention to the preceding remarks. In addition I would say that he misinterprets my point of view if he supposes that I am opposed to defining energy. If I knew how I would define it myself. Elsewhere[4] I have stated what I conceive constitutes the laws of energy; and those three laws are as near as I can come to a "definition of energy." If he can produce a definition that will convey the necessary information and not conflict with known facts and laws the scientific world will doubtless welcome it with open arms. The field is open. But a *definition that claims to be general* and leaves out, or even is in opposition to, the most important characteristic of the thing supposed to be defined is worse than no definition at all. The absence of a "definition" does not preclude the clarifying of our thought by diligent study of the thing we wish to define. As an aid to study, a provisional, or partial definition may often be of great assistance as a working hypothesis provided it is recognized as provisional and not allowed to close our minds to evidence and dominate our perceptive powers.

M. M. Garver
The Pennsylvania State College

[2] *Journal of Physical Chemistry*, Vol. 15, p. 613 (1911).

[3] June 16, 1916.

[4] *Loc. cit.*

"AVAILABLE ENERGY" VS. "ENERGY"

To the Editor of Science: The argument between the scientist and the engineer over the definition of energy is clearly saturated enough to crystallize out the clean-cut definition of "available energy" and leave the indefinite but exceeding rich mother-conception of "energy" for those who shall see more clearly or be able to unite our bewilderment of facts and deductions to a concrete statement.

The communication of Professor Garver in the April 21 issue is both a timely and an excellent critique. Evidently he analyzed the difficulty far better than he constructed a working presentation or Dr. Wm. Kent would not have been able to so well establish himself in the reply of June 9.

That the author of a leading engineers' handbook should express himself as Kent has done may be considered as evidence to demonstrate the narrow conceptions and limited field into which practical men continually fall. From the energy-to-sell point of view there certainly is satisfaction in the Kent definition; but we can not allow Dr. Kent to confine the use of the term "energy" to engineering; the engineer clasps hands with the scientist in every undertaking and acknowledges his past and present effort as components of his own practicability.

The men who have most carefully studied thermodynamics and energy transformations assert that one particular sort of energy manifestation can be designated as *free* energy, *available* energy or by some factor indicating *potential* or *intensity* variation. The "stored work" is to be referred to this sort of energy, but the converse is not true—that all the energy in a given system which may thus be described can be converted into work. With Garver we have to say that a certain amount of work may be done during the *transfer* or adjustment of this sort of energy. Some energy is always lost, as heat when the work is done. We find, then, that Kent is careless in using "energy" where he should say "available energy" and he is inaccurate in assuming that *all* such energy is transformable into mechanical work.

Recent writers often state the matter with much conciseness:

Bryan:[1]

We are thus led to the conclusion that under any given conditions only a limited portion of the energy of a system can be converted into mechanical work. This portion is called the *available energy* of the system subject to the given conditions. In order, however, to completely define the available energy of a system, it is necessary to specify not only the external conditions to which the system is subject, but also the means at our disposal for converting energy into useful work.

Nernst:[2]

If any system whatever is subjected to any desired changes, these are, in general, identified with the following changes in energy: firstly, a certain amount of heat is either absorbed or given out; secondly, a certain amount of external work is either performed by the system or is performed against it; thirdly, the internal energy of the system will either diminish or increase. In general in any event the diminution of the internal energy U must be equal to the external work A accomplished by the system, minus the amount of heat Q absorbed; *i. e.*, the following relation exists:

$$U = A - Q.$$

Rushmore:[3]

From a practical standpoint energy may be classified as *available energy*, or that which can be turned into mechanical energy, *and unavailable energy*, or that which is practically useless for the purpose. To the latter belong the enormous sources of energy stored in the earth's rotation, as well as the interior heat of the earth.

There are several reasons why we shall never return to any former conception of the term "energy" as Dr. Kent in his last paragraph hints might yet be done.

Every new study of the relationships only strengthens the division as made above in the three quotations. This view has been expounded so long and widely and is so firmly established in all collegiate education that there is slight excuse for combating it. It is true that investigation and deduction increase our knowledge of energy without disclosing any ultimate interpretation, exactly as in the case of gravitation, yet the laws of transfer and transformation are always found to hold most rigidly. These laws of the conservation of energy and the degradation of energy are ever becoming more valuable and firmly established.

Recent discoveries and conceptions only render a definition or unqualified statement of what *energy* IS more and more difficult.

The development of radioactivity has enormously broadened our field of knowledge on energy and set us irrevocably beyond our past. We find "energy" and "matter" meeting on common ground and know not which from t'other.

The development of quantum theory and the study of radiations again shatter any previous notion of energy and portend that energy ideas of the future must involve some aspect of granularity and distribution function.

All the studies on the constitution of matter and the structure of atoms presage radical change and new methods; in dealing with whole classes of energy we are finding the limits of the application of the gross laws of energetics. It is highly significant to follow the mathematical physicist who with much pains in logic comes inevitably to the conclusion that the ether has infinite energy—a conclusion he will likely abruptly discard as absurd!

With matter, ether and energy as possibly only different aspects of, or approaches to, the same ultimatum, who can imagine that our ideas will ever again fit into the long-discarded and outgrown definition.

Useful work may comprise the chief end of the engineer's effort, but it can do him only good to have ever present the concept that relatively only a negligible part of our energy universe concerns itself with such work. It would certainly be a great misfortune to have a statement about energy so terse as to deny the greatest and most useful of our generalizations.

H. B. PULSIFER
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[1] "Thermodynamics," p. 35, 1907.

[2] "Theoretical Chemistry," trans. of sixth German text, p. 8, 1911.

[3] *General Electric Review*, p. 422, May, 1916.

"TYPUS" AND "TYPE" IN TAXONOMY

THERE is a general attempt among systematic zoologists and botanists to limit the words "type" and "typical" and their equiv-

alents in other modern languages to their strictly taxonomic meanings, *e. g.*, "type species," "typical genus," "type specimen," rejecting their use in their long recognized more general sense. The attempt to restrict a word in general use to a new technical meaning is always difficult and rarely is wholly successful.

May I suggest a way around the difficulty in the case of these words? If in its strictly taxonomic use the word be given its Latin form, *typus*, there will be no ambiguity. It would accomplish the purpose if all zoologists and botanists would abandon the use of the English words type and typical or their equivalents in other modern tongues, thus avoiding all chance of confusion, but this can hardly be secured. On the other hand, taxonomists, who have in mind the taxonomic conventions, might be expected to conform to a better usage, if recommended, and use only the Latin form for the technical meaning. It is easier to bring taxonomists to this better usage than it is to persuade all biologists to abandon the ordinary non-technical use of the vernacular equivalents of the word *typus*.

MAYNARD M. METCALF
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QUOTATIONS

SCIENTIFIC DEVELOPMENT IN RUSSIA

A REVIEW, however cursory, of scientific work in Russia during the past two years must take account of two features of outstanding interest and importance. One is the appointment, on the initiative of the Imperial Academy of Sciences of Petrograd, of a commission to investigate and report on the natural resources of the Russian Empire with a view to their scientific and practical development and utilization.

Stated in one bald sentence this may not appear particularly impressive, but looked at through the lens of imagination it is revealed as a stupendous project with far-reaching aims and destined to lead to incalculable results. The prime incentive is the fact that in Russia, as elsewhere, the eyes of the nation have been opened and attention has been focused on what was in times of peace known to many, deplored by some, and passively acquiesced in by all: the extent to which its economic life has been honeycombed by the greater energy, enterprise and initiative of the Germans. It is now realized that this economic dependence, extending to many things which might just as well have been supplied by native industry, went far beyond the limits of a natural and legitimate exchange of products between neighboring countries, and the empire is firmly resolved to make a determined effort to put an end to an intolerable anomaly. Russia stands at the parting of the ways, and we in this year of grace are, it may be, witnessing the economic birth of a nation.

As may be supposed, the development of such a comprehensive scheme to the point of effective utility has not been accomplished without much discussion and some hostile criticism. One critic "doubts if the time is well chosen for embarking on such an ambitious enterprise when the strength of the empire is being taxed to the utmost by this terrible war. The end proposed is highly desirable, but . . . the program is so enormous that the preliminary steps alone will take years, to say nothing of the long interval that must elapse between scientific investigation and practical fruition . . ."; and he goes on to point out many problems to the immediate solution of which the academy might in this crisis more profitably apply its energies. However, the commission has in a surprisingly short time got to work—the first sitting took place only in October of last year—and is issuing a series of monographs, several of which have already been published, each written by a specialist, dealing, by way of a commencement, with the vast field, in many directions undeveloped, in others lying fallow, of Russian mining and metallurgy.

The other item of interest is the convening of a conference by the Imperial Academy of Sciences to consider the proposal to found a Russian Botanical Society with its own official journal. There is a great deal of botanical investigation carried on in Russia by various

institutions scattered all over the country, but it is felt that great advantage would accrue from coordination and centralization, and that the founding of such a society is only the just due of the importance of Russian botany "in view of the eminent position which Russia is destined to occupy after the war."

But side by side with these special activities, which are the direct outcome of the quickening of the nation's pulse, there is, as in normal times, a great amount of quiet, unobtrusive research in the domains of biological and physical science. Though there may be no epoch-making discovery to record, there is scarcely a field of mental activity left untilled. Many a peaceful backwater is being navigated undisturbed by the clash of arms, and it is pleasant to read of ethnographical and philological investigations, or of an expedition to the Jablonovy Range to study the local fauna, with its picturesque account of explorations in steppes, morasses and virgin forests. It is interesting to note, in this connection, that there is scarcely a provincial town of any importance in Russia without its medical society and association of local naturalists, or, as the charming Russian idiom has it, "lovers of nature lore," true amateurs in the best sense of the word and all contributing their quota to the common stock. Worthy of mention also are the efforts made for the preservation, as far as may be possible in the circumstances, of valuable treasures of art, science and archeology in the war-zone, such efforts not to be confined to the limits of the empire, but to be extended to enemy territory occupied by Russia. It is pointed out that priceless products of human culture may be saved if timely measures be taken, and to this end the service of various scientific experts has been secured and the sympathetic cooperation of the military staff enlisted.

Finally, mention must be made of the decision of the Imperial Academy of Sciences on the question of the exclusion of alien enemies from the list of honorary members. As the result of a conference held in March of last year to consider the matter the academy expresses itself as loath, by such exclusion, to place any obstacles in the way of the resumption after the war of that international cooperation for the progress of science which will, it foresees, play a greater part than ever in the development of European civilization, "when an end has been made of those hegemonistic strivings which, not content with the sphere of politics, have invaded that of science." Truly a dignified attitude, worthy of an august institution which can look back with just pride on well-nigh two centuries of enlightened effort and solid achievement.—*Nature.*

SCIENTIFIC BOOKS

X-rays and Crystal Structure. By W. H. BRAGG and W. L. BRAGG. G. Bell & Sons, Ltd., London, 1915. Pp. i + vii, 1–228.

All physicists who are at all familiar with the magnificent work which in the two short years between October, 1912, and October, 1914, W. H. and W. L. Bragg did in unfolding the nature of X-rays, revealing the structure of crystals and in laying the foundations for Moseley's brilliant discovery of a relationship between the elements more fundamental than that represented by the periodic table, are agreed that no Nobel prize was ever more justly placed than that which has recently gone to the Braggs. It is the lucid and succinct account of this very new work which constitutes the present book—a book which will always remain a classic, not merely because it is the first book in its field and written by the men who have themselves contributed most largely to the ushering in of the new epoch, but also because it is an unusually fine example of clear, direct and fascinating exposition.

None of the twelve chapters except the fourth, the sixth and the last contain any appreciable material other than that which the authors themselves have contributed. Despite the generous and deserved recognition which they make of the part which Laue played in starting their studies, it is very largely to the Braggs that the world owes the creation of the new subject of X-ray spectrometry, and so long as young men are appearing in England of the caliber of W. L. Bragg and of Moseley, the latter of whom at the age of twenty-seven

had turned out as fine a piece of work as has appeared in fifty years, so long will English physics remain preeminent.

The first chapter reviews briefly the older theories of X-rays and presents Laue's discovery and photographs. The second presents the Bragg theory of the diffraction of X-rays, the third describes in detail the Bragg X-ray spectrometer, the fourth is a brief account of the properties of X-rays. The fifth merely describes crystal structure, little known to most physicists, and the sixth presents our present knowledge of X-ray spectra, and includes an admirable report on Moseley's work. The remaining six chapters present the Bragg analysis of crystal structure made by means of their spectrometer.

Few books have ever appeared which represent in so high a degree the creative work of the authors themselves.

R. A. Millikan

Ryerson Physical Laboratory

An Elementary Manual of Radio-Telegraphy and Radio-Telephony for Students and Operators. By J. A. Fleming, M.A., D.Sc., F.R.S. Third edition. Longmans, Green & Co., 1916. Cloth, 360 pages, 194 illustrations.

This is an excellent elementary text-book on the principles of radio-communication, with enough history inserted parenthetically to add descriptive interest, without sensibly distracting attention from the main line of exposition.

Like all of Dr. Fleming's writings, it is particularly strong on the quantitative side. Nevertheless, the mathematics employed are not difficult.

The book is divided into nine chapters, relating to the following topics: Electric Oscillations, Damped Electric Oscillations, Undamped Electric Oscillations, Electromagnetic Waves, Radiating and Receiving Circuits, Oscillation Detectors, Radio-telegraphic Stations, Radio-telegraphic Measurements, Radio-telephony.

The chapter dealing with radio-telegraphic measurements is particularly good.

A blemish in the didactic method is the use of English units of measure in a few of the examples. The complexity involved in the arithmetic, by reference to such archaic and unscientific units, repels the student more than a transition from English to metric units before attacking the problem, and a final transfer from metric to English units in stating the results.

The book will be of great value to students of radio-telegraphy, and to operators seeking to improve their knowledge of their work on the scientific side.

A. E. Kennelly

The Institutional Care of the Insane in the United States and Canada. By Henry M. Hurd, W. F. Drewry, R. Dewey, C. W. Pilgrim, G. A. Blumer and T. J. W. Burgess. Baltimore, The Johns Hopkins Press, 1916. Pp. 497, 30 pl. Edited by Henry M. Hurd, M.D. $2.50.

This is one of the few works in the English language in which the history of a separate branch of medicine has been exhaustively treated. The editor, Dr. Hurd, prior to his election as superintendent of the Johns Hopkins Hospital in 1889 and after, has had a long practical experience in institutional psychiatry, and there is probably no other authority in this country so well fitted for the difficult task delegated to him and his associates. The four volumes of this work, when completed, will comprise no less than a full set of separate histories of all the insane hospitals in the United States and Canada. The present volume, although it professes to deal only with the general history of institutional care of the insane on this continent, is, in reality, an exhaustive history of American psychiatry in all its phases, and is therefore likely to remain the authoritative work on the subject for an indefinite period. In this history, there are no great outstanding names, like those of Pinel or Tuke or Griesinger, unless it be that of a woman, who was the prime mover of our improved institutional care of the insane. The record is one of collectivism, of the patient labors of societies, journals and individual propagandists for the good of a much-neglected class of human suffering. Matthew

Arnold, under the influence of Renan, ridiculed the "bold, bad men" who frequent social-science congresses; but it was largely through foregatherings of this order, their patient endeavors with legislative bodies, that we get this record

> Of labor, that in lasting fruit outgrows
> Far noisier schemes, accomplished in repose.

The history, from the crude pioneer conditions to the advent of the psychopathic hospital, where insane patients are no longer pauperized or imprisoned but treated as so many cases of acute disease, traces the slow evolution of a definite series of ideas. It begins with the foundation of the Association of Medical Superintendents of American Institutions for the Insane (October 16, 1844), and the subsequent history of this body, which became the American Medico-Psychological Association on June 6, 1893. A careful synoptic account of all the transactions is given. Among the items of note are Luther Bell's original description of phrenitis or "Bell's mania" (1849), the introduction of the famous "propositions" by T. S. Kirkbride (1851), Field's discussion of hæmatoma auris in the insane (1894), a condition which he showed to be identical with the aural deformity found in antique statues of athletes and in modern boxers and wrestlers (*Pancratiastenohr*), and Weir Mitchell's drastic arraignment of the status of American asylums (1894), which, at the time, was adjudged somewhat premature and captious by our alienists. A chapter on the history of the *American Journal of Insanity* (founded 1844) is followed by chapters on the early and colonial care of the insane, the evolution of institutional care, of the administration of hospitals and their construction, of training schools for nurses and attendants, of state and private care, of the psychopathic hospital and of legislation, the latter part of the volume being taken up with the psychiatric aspects of immigration, insanity in the negro, the Indian, the Chinese and Japanese, the census of the institutional population and the history of Canadian psychiatry. In the Colonies, the psychiatric burden was thrown mainly upon the town councils, which usually meant the pauperization of the insane in county jails, work-houses and almshouses. Under the healthy *plein air* conditions of colonial life, this burden was probably light. It is of record that a large donation for an asylum was declined by colonial Boston on the ground that there were no insane to put in it. In Maryland and Virginia, the custody of the pauper insane and the poor was delegated to the Established Church. The first state hospital (incorporated 1768) was opened at Williamsburg, Va., in 1773. The "era of awakening" (an important chapter) came slowly. It comprised the erection of such hospitals as the Bloomingdale Asylum (1821), the McLean Hospital (1818), the asylum at Lexington, Ky. (1824), the Hartford (1828), and Brattleboro Retreats (1836), and above all the wonderful propagandist labors of Miss Dorothea L. Dix, of whose life a full account is in preparation by Dr. C. W. Page, of Hartford. This remarkable woman practically created institutional psychiatry in Massachusetts, Rhode Island, New Jersey, through the south and west, and even accomplished much in Scotland and England. Her efforts were based upon most careful investigation beforehand and her success was due to the fact that she was an eminently reasonable person, with the unique power of producing convincing facts and of making unanswerable statements at the right moment. This was something different from the usual course of "making a noise like a reformer." After a brief conference with her, a rough New Jersey legislator said: "I do not want to hear anything more. You've conquered me out and out. I am convinced." In Scotland, where the frowardness of women is eyed askance, she incurred the enmity of the Lord Provost of Edinburgh, beat the hostile official in a midnight race to London, and so impressed the statesmen there, that she secured Queen Victoria's order for two commissions of investigation (1885). In Parliament, the member from Glengarry, Mr. Edward Ellice (Prosper Mérimée's old friend), said that "the commission was entirely due to Miss Dix's exertions."

She was a "moral Columbiad," rather than the "Moral Bully" of Dr. Holmes's aversion.

The principal defect of early American care of the insane was that it was mainly a local enterprise, delegated to counties and county officials, men who had "an eye single to the taxpayer," whose chief aim was to establish a reputation for economy as a means of securing reelection to office, with the result that the county asylums were practically poorhouses. This has been notably the case with the so-called Wisconsin system of county care of the chronic insane (1881), which is the subject of an able critique. State care, by which is meant the proper care of all the insane in the state in a suitable state-supported hospital, as distinguished from state support of a limited number, with the rest in county almhouses, is a plant of recent growth. The earliest state hospitals were those at Williamsburg (1773), Columbia, S. C. (1828), Worcester, Mass. (1833), and Utica, N. Y. (1843). The New Hampshire State Care Act did not become operative until 1913. In this field, New York state leads, with the institutions at Willard, Binghamton, Middletown, Poughkeepsie, Buffalo, Ogdensburg, Auburn, Matteawan and Dannemora. Next to Binghamton in size comes the admirable Government Hospital at Washington, D. C., which, under the able administration of Dr. William A. White, is now a community of over 4,000 persons. The psychopathic hospital, a development of Griesinger's idea of a (university) psychiatric clinic, combines the features of voluntary admission, temporary detention, non-restraint and continuous medical observation and treatment. Such institutions or wards now exist at Albany, N. Y., Ann Arbor, Boston, Waverly (Mass.), Providence, White Plains and Washington, D. C. The best example is the recent Henry Phipps Psychiatric Clinic at Baltimore, under the direction of Dr. Adolph Meyer. England and France have left their mark upon the architecture of our earlier insane hospitals. Later institutions have followed the plan evolved by Kirkbride for the Pennsylvania Hospital which consisted essentially of a large central administration building, with extended wings on each side for the separation of the sexes. Details were governed by the "cast iron rules" of the "propositions," a set of hard and fast regulations evolved by the association (1844–1875) for the construction and organization of asylums (Kirkbride) and the legal management of the insane within them (Isaac Ray). The cottage plan and the farm colony are later developments. Of the Buffalo State Hospital, the most extreme example of the old Kirkbride plan, Dr. Hurd says that "the medical officers must walk a distance of half a mile from the administration building to reach the farthest ward on either side," which suggests the flatboatmen on the Potomac River, who, in poling their craft, walk just twice the distance they travel.

Dr. Hurd modestly regards this work as a source-book for the historians of the future, but it is undoubtedly a permanent history, which may be extended but will hardly be duplicated. The chapters are complete in themselves, the book is well-illustrated and the style is charming in its simplicity, sobriety and its traces of delicate humor. A complete index to the whole work, which may be expected at the end of the fourth volume, will make it invaluable for ready reference.

F. H. Garrison

Army Medical Museum

PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES

The fifth number of Volume 2 of the *Proceedings of the National Academy of Sciences* contains the following articles:

1. *Differential Equations and Implicit Functions in Infinitely many Variables:* William L. Hart, Department of Mathematics, University of Chicago.

Three problems are handled: First, Certain fundamental theorems concerning a type of real-valued functions of infinitely many real variables. Second, The problem of infinite systems of ordinary differential equations. Third, The fundamental problem of implicit function theory in this field.

2. *The Sex of Parthenogenetic Frogs:* JACQUES LOEB, Rockefeller Institute for Medical Research, New York.

Two frogs obtained by artificial parthenogenesis, one ten months old the other thirteen months old, were found to be males, and the thesis that animals produced by artificial parthenogenesis are males is thus further corroborated.

3. *De Vriesian Mutation in the Garden Bean, Phaseolus Vulgaris:* J. ARTHUR HARRIS.

The origin of the new race of beans seems most logically explained as a case of de Vriesian mutation. In this race the whole morphological organization of the seedling has apparently been changed and the race is characterized by a high degree of variability.

4. *Studies of Ductless Glands by the Electrical Method:* W. B. CANNON, Laboratory of Physiology, Harvard University.

The nerves distributed to the thyroid cells belong to the sympathetic and not to the vagus supply, and their effects are not indirect through alterations of blood flow. They are true secretory nerves.

5. *The Distribution of the Chondriosomes to the Spermatozoa in Scorpions:* EDMUND B. WILSON, Department of Zoology, Columbia University.

The chondriosome-material having the same origin, fate and (presumably) physiological significance may be distributed to the germ-cells by processes widely different even in nearly related animals. In one of the scorpions the distribution is effected by a definite process of division, in the other by an operation that has at least the aspect of a hit-or-miss segregation, and one that gives only an approximate equality of result.

6. *New Data on the Archeology of Venezuela:* HERBERT J. SPINDEN, American Museum of Natural History, New York.

Stone implements, including celts, pestles, etc., vessels and figurines of clay with painted and modeled decorations, personal ornaments of shell, nephrite, jet, and serpentine, as well as the petroglyphs and pictographs, occur in considerable quantity. The plastic art of Venezuela is one and the same with the "archaic art" already known in Central America and Mexico.

7. *Note on the Phosphorescence of Uranyl Salts:* EDWARD L. NICHOLS, Department of Physics, Cornell University.

For the only examples of luminescence which admit of detailed inspection, the spectrum of phosphorescence is identical with that of fluorescence and it is suggested that this also applies to all phosphorescent materials. In spite of its great complexity, the luminescence spectrum of a uranyl salt is to be regarded as a unit, all its components decaying at the same rate after the cessation of excitation.

8. *The Pyranometer: An Instrument for Measuring Sky Radiation:* C. G. ABBOT AND L. B. ALDRICH, Astrophysical Observatory, Smithsonian Institution.

Two satisfactory types of this instrument, both derived in principle from the electrical compensation radiation instruments of the late K. Ångström, have been devised. Numerous observations of the sky-radiation have been made. On fine days the sky-radiation alone received on a horizontal surface ranges from 0.07 to 0.13 calories per square centimeter per minute.

9. *Note on Lucas' Theorem:* M. B. PORTER, Department of Mathematics, University of Texas.

A more general result than that obtained by Borel or Polya has been found.

10. *A Variable System of Sevens on Two Twisted Cubic Curves:* H. S. WHITE, Department of Mathematics, Vassar College.

11. *The Neuromuscular Structure of Sea-Anemones:* G. H. PARKER AND E. G. TITUS, Zological Laboratory, Museum of Comparative Zoology, Harvard College.

There are four types of muscle action; they are of phylogenetic significance, and show that the neuromuscular mechanism of sea-anemones is by no means so simple as originally supposed.

12. *Change of the Ionization of Salts in Alcoholic Solvents with the Concentration:* FREDERICK G. KEYES AND W. J. WINNINGHOFF, Research Laboratory of Physical

Chemistry, Massachusetts Institute of Technology.

The present investigation on the conductance of sodium iodide and ammonium iodide in isoamyl alcohol and of sodium iodide in propyl alcohol was undertaken for two purposes: primarily to determine whether in these solvents, somewhat similar in nature to water, salts conform to the mass-action law at very small concentrations; and secondarily, to test further the applicability of Kraus' empirical equation throughout the fairly wide range of concentration employed in the work.

Edwin Bidwell Wilson
Massachusetts Institute of Technology

SPECIAL ARTICLES

A NEW MITE FROM THE HAWAIIAN ISLANDS

Recently, while visiting the Hawaiian Islands, my attention was called to a Chinese Litchi (*Litchi chinensis* Sonn.), growing on the grounds of the United States Experiment Station at Honolulu, which was very seriously infested by an apparently new species of mite. The injury caused by this mite is of the familiar erinose type, being produced on the lower side of the leaf. In many instances practically the entire lower surface of a leaf was covered with a light brown erineum, but more often distinct patches of variable size were produced. Badly attacked leaves assumed the general characteristics of peach leaves infected by the leaf-curl fungus (*Exoascus deformans*).

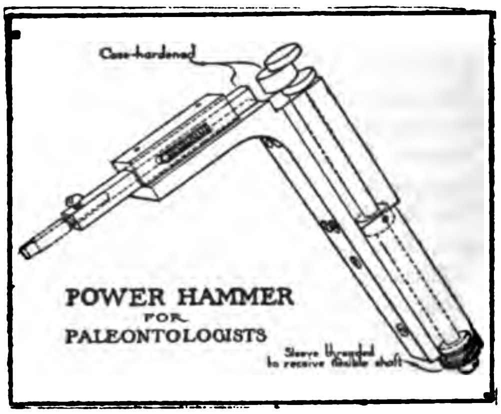
So far as could be learned, the infestation seemed to have been more or less sudden; at least, none was noticed until the injury had become very marked. The tree is considered very valuable and the infestation was so serious as to greatly endanger its life.

It was readily determined that the mite belonged to the genus *Eriophyes*. Specimens of infested leaves were referred to Dr. Nathan Banks through Dr. L. O. Howard, chief of the U. S. Bureau of Entomology. Dr. Banks indicates that the mite is a new species of *Eriophyes*. He also states that, so far as he can find, no mites have ever been recorded from the Litchi, and, further, that very few mites have been recorded from China. There is, therefore, a possibility that the Litchi, although imported from China, later became infested by a mite of Hawaiian origin.

P. J. O'Gara,
Chief in Charge
Department of Agricultural Investigations,
American Smelting and Refining Company,
Salt Lake City, Utah,
March 16, 1916

A POWER CHISEL FOR PALEONTOLOGIC LABORATORIES

The extremely slow, laborious and difficult task of separating fossils from the enclosing matrix, in the old manner, led W. W. Kelley, a senior student of marked mechanical ingenuity, to devise a power chisel, which has been installed in the geologic laboratories of Washington University. Thus far the device has proved so satisfactory to the members of the department that it is thought best to pass the information along to other toilers in the profession.



The chisel proper is extremely simple, consisting of an L-shaped frame in one arm of which is a shaft bearing a balanced eccentric head and, at right angles, in the other, a square plunger holding the chisel point. One blow during each revolution (1,800 a minute) is dealt by the protruding part of the eccentric striking the head of the plunger. A spring holds the plunger away from the eccentric when not in use. The eccentric shaft of the chisel is connected directly to the armature shaft of a one eighth horse-power motor by a

flexible driving shaft, similar to those of the dental engines.

In work upon the larger specimens the chisel frame is held in the hand, the flexible shaft permitting of considerable freedom in manipulation. In the case of smaller specimens, it has been found best to secure the chisel frame in a vise and to hold the specimen in the hand. Putting the chisel in operation consists solely in pressing it against the specimen in the first case, or the specimen against it in the second. Probably of more importance than the speed, is the control of the length of the stroke, and hence of the liability of injury to the specimen. The full stroke is only one fourth of an inch, and by pressing lightly the stroke can be reduced to an extremely small fraction of an inch.

WILLIAM C. MORSE
WASHINGTON UNIVERSITY

THE OHIO ACADEMY OF SCIENCE

IN accordance with the amendment of the constitution, adopted at the quarter-centennial anniversary in November, 1915, the twenty-sixth annual meeting of the Ohio Academy of Science was held at the Ohio State University, Columbus, Ohio, on Friday and Saturday, April 21 and 22, 1916. Fifty-five members were in attendance.

The presidential address by Professor George D. Hubbard, of Oberlin College, was on the subject "What Has the Future for Geologists?" On Friday evening a joint session of the academy with the Ohio College Association and other affiliated societies was addressed by Professor Charles H. Judd, of the University of Chicago, on "The More Complete Articulation of Higher Institutions with High Schools." On Saturday morning the academy adjourned for a symposium of the Ohio College Association, addressed by representatives of the various affiliated societies. The academy was represented by Professor Lewis G. Westgate, of Ohio Wesleyan University, who spoke on "The Relation of the College to Research."

The remaining scientific program was as follows:

ARCHEOLOGY

"Exploration of Tremper Mound," by W. C. Mills.

BOTANY

"A New Three-Salt Nutrient Solution for Sand and Water Cultures," by A. G. McCall.

"An Adjustment of the Sliding Microtome for Cutting Lignified Tissue," by Forest B. H. Brown.

"Notes on the Structure and Function of the Green Layer of the Bark of Woody Plants," by Forest B. H. Brown.

"The Distribution of Fungi in Porto Rico," by Bruce Fink.

"The Genus *Physcia* in Ohio," by Martha McGinniss, introduced by Bruce Fink.

"A Relative Score Method for Unmeasured Characters," by A. G. McCall.

"The Revegetation of the Katmai District of Alaska," by Robert F. Griggs.

"Decrease of Permeability with Age" (Preliminary Note), by H. M. Benedict.

"Methods of Spore Formation in the Zygnemales," by E. N. Transeau.

"Notes on the Germination of Tree Seeds," by William R. Lazenby.

"The Quince Leaf-Spot," by W. G. Stover.

"A Blade Blight of Corn," by W. G. Stover and W. N. Ankeny.

"The Occurrence of the *Volutella* Rot in Ohio," by Gustav A. Meckstroth.

"Observations on the Ontogeny of the Gall of *Pachypsylla mama* Riley," by B. W. Wells.

"Botanizing in Porto Rico," by Bruce Fink.

"Parthenogenesis in the Dandelion," by Paul B. Sears.

"The Educational Value of Wood Study," by A. B. Plowman.

"A New Method for Marking Slides," by Paul B. Sears.

"Certain Points in the Celloidin Method" (Demonstration), by A. B. Plowman.

ZOOLOGY

"Parallelism between the Cystid Agelacrinites (fossil) and the Holothurian *Psolus* (recent), with Demonstrations," by Stephen R. Williams.

"The Axial Rotation of Microorganisms and its Evolutionary Significance," by L. B. Walton.

"Notes on Ohio Tingitidæ," by Carl J. Drake.

"Insect Population of Grasslands," by Herbert Osborn.

"Genitalia of the Bedbug with special reference to a Unique Method of Copulation," by P. B. Wiltberger.

"The Origin of the Gasserian and Profundus Ganglia in *Rana*," by Ralph A. Knouff, introduced by F. L. Landacre.

"The Fusion of the Gasserian and Profundus Ganglia in *Plethedon*," by Katharine Okey, introduced by F. L. Landacre.

"The Origin of the Placodal Ganglia in *Squalus*," by C. I. Reed, introduced by F. L. Landacre.

"Concerning Thyroid Glands in Amphibia," by R. A. Budington.

"Feeding Thymus and Thyroid Extracts," by E. P. Durrant.

"Notes on Protozoa. (*a*) A Review of the Arcellidæ. (*b*) Supplement to the Euglenoidina," by L. B. Walton.

"Notes on Birds," by H. A. Albyn.

"A Recent Ohio Specimen of Henslow's Sparrow" (Demonstration), by Edward L. Rice.

GEOLOGY

"On Wavemarks," by Walter H. Bucher.

"The Northward Extension of the Physiographic Provinces of the United States," by W. N. Thayer.

"Additions to the Anatomy of *Lepadocystis moorei*," by W. H. Shideler.

"Crystals," by W. N. Speckman.

PHYSICS

"Resistance of Electrolytes by a modification of Kohlrausch's Method," by M. E. Graber.

"Demonstration of Apparatus showing Analogy between Reactance Phenomena in Alternating Current Circuits and in Fluids," by F. C. Caldwell.

"Absorption of High Frequency X-rays," by S. J. M. Allen.

"The Symbols used in Geometry," by John H. Williams.

The trustees of the Research Fund reported a further gift of $250 from Mr. Emerson McMillin, of New York, for the encouragement of the research work of the academy. Since the last meeting a grant to L. B. Walton has been paid, and new grants made to L. S. Hopkins, F. L. Landacre, W. H. Shideler, B. W. Wells and Stephen R. Williams.

Gratifying progress was reported by the committee on scientific journals. The scope of this work, in which the academy is cooperating with the Ohio Library Association, is shown by the following paragraphs from the appeal for cooperation mailed to all important libraries in the state: "The Ohio Academy of Science and the College Section of the Ohio Library Association jointly propose to compile a union catalogue of the periodical and scientific sets (except documents) in the libraries of the state. This catalogue is to be made on cards, and filed with the Ohio State University Library, the official depository of the Ohio Academy of Science. Ultimately the academy hopes to print this union catalogue for the benefit both of librarians and of scientists. However, until printed, it will be possible for any one to write directly to the Ohio State University Library and secure information concerning the location of any scientific set in the state."

"The Ohio Academy of Science has been working on such a proposition for several years, and much of preliminary data has been received. At the October, 1915, meeting of the Ohio Library Association a committee was named to compile a union catalogue of periodical sets so that librarians might know where sets are when needed by them in the various universities and colleges."

"Therefore, this joint effort of the two associations, as outlined above, will bring into existence a bibliographical tool, the value of which will be indispensable to the college librarians and to the scientists of the Ohio Academy."

Obituary notices of Professor F. M. Webster, of Washington, D. C., and Professor John Royer, of Bradford, Ohio, were presented by the Committee on Necrology.

Sixteen new members were elected.

The officers for 1916–17 are as follows:

President—Professor F. O. Grover, Oberlin College.

Vice-presidents—(Zoology) Professor Stephen R. Williams, Miami University; (Botany) Professor E. L. Fullmer, Baldwin-Wallace College; (Geology) Professor August Foerste, Steele High School, Dayton; (Physics) Professor M. E. Graber, Heidelberg University.

Secretary—Professor E. L. Rice, Ohio Wesleyan University.

Treasurer—Professor J. S. Hine, Ohio State University.

Executive Committee, in addition to the President, Secretary and Treasurer, members ex officio—Professor L. B. Walton, Kenyon College; Professor Bruce Fink, Miami University.

Trustees of Research Fund—Professor W. R. Lazenby, Ohio State University; Professor N. M. Fenneman, University of Cincinnati; Professor M. M. Metcalf, Oberlin College.

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SCIENCE

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CONTENTS

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THE METHOD OF GROWTH OF THE LYMPHATIC SYSTEM[1]

IN selecting a title connected with the general subject of the lymphatic system, I have chosen to emphasize the phase of the subject with which the anatomist of to-day is concerned. As a matter of fact, in studying the problem of growth he is seeking to understand the nature of the lymphatic capillary. This is no new problem, but rather it has dominated the study of the lymphatic system for nearly three hundred years. The colorless fluid of the tissues was called lymph long before lymphatics were discovered. It was thus natural that when vessels were discovered containing this fluid they were called lymphatics. As soon as the lacteals and then the general lymphatics were discovered, the question arose in regard to the nature of these vessels, what was their extent and how they ended in relation to the surrounding tissues. At first the lymphatics were thought to begin in wide mouths in the walls of the various cavities of the body, and then, as these openings proved difficult to find, attention became focused on the relation of the lymphatics to the tissues. The number of terms which have been used in seeking to analyze the relation of the lymphatics to the tissues—for example lymph radicles, lymph rootlets, lymph spaces, parenchymal spaces, tissue spaces—will serve to illustrate how persistent has been the quest of the anatomist to understand the lymphatic capillary. Stated in other terms, this is the time-honored question of open and closed lymphatics. In presenting to you the conception

[1] Address delivered to the Harvey Society of New York City on December 18, 1915.

of lymphatic capillaries as definite vessels completely lined by endothelium, and related to tissue-spaces just as blood-capillaries are, it will be necessary to emphasize first the importance of tissue-spaces. Indeed, the general subject of tissue-spaces, as important systems in the body, related to blood-capillaries and to lymphatic capillaries in function, is, I believe, nowhere sufficiently emphasized in the literature.

It is well known that the plasma of the blood is constantly exuded from the blood-vessels into the tissue-spaces, so that all the cells of the supporting tissues, as well as the special cells of each organ, are bathed in fluid. Moreover, it is obvious that with all the varying activities of the cells of the body, the fluid becomes laden with different nutritive and with different stimulative substances and with different waste products, so that it varies widely in its composition. The subject of tissue-spaces—meaning not empty spaces, but spaces which always contain fluid—is by no means a simple one. There are primarily the general, small spaces to which I have just referred, between all of the fibers and cells of the connective tissues and between the parenchyma of each organ and its supporting tissues: but there are also special systems of great spaces, which arise from the small spaces by a definite method, which have a definite structure and contain a fluid which is different from the other fluids in the body—such, for example, as the subarachnoid spaces which surround the central nervous system.

That the cerebro-spinal fluid is secreted by a special organ and contains certain products of internal secretion is now known. The pia-arachnoid membrane has been shown by Weed[2] to have an extremely interesting structure and development. I will mention here only the very important arachnoidal villi which are lacelike projections of the arachnoid into the dura. They lie along the dural veins and lead to the dural sinuses. These villi, which he has shown to be the main organs of absorption for the cerebro-spinal fluid, are covered with a layer of mesothelial cells, which tend to become more abundant at the tips, forming cell nests.

Other great systems of spaces are found in the internal ear and in the eye. The scala tympani and scala vestibuli of the cochlea have been called peri-lymphatic spaces, though they have no relation to the lymphatic system. These spaces of the ear have just been shown by Streeter[3] to have a most interesting development. The scala tympani and scala vestibuli are formed from spaces in the mesenchyme which at first become slightly larger than the usual spaces and then coalesce into still larger spaces. Moreover, this process is not indefinite, but has two distinct places of origin, one between the sacule and the oval window and the other between the cochlea and the round window. From these two areas the formation of the two great spaces of the cochlea proceeds in a definite and constant direction, so that a model of their form from one specimen is the same as that from any other specimen of the same stage. Moreover, when studied in sections this process appears to be a gradual dilatation of preexisting tissue-spaces, with a disappearance of more and more of the original connective tissue syncytium, rather than being caused by a differentiation of the mesenchyme cells forming the border of these spaces. As the cavity thus formed reaches its ultimate dimensions some of the remaining mesenchyme cells do differentiate to form a mesothelial lining. I emphasize this method of the formation of a cavity out of mesenchymal spaces, for the

[2] Weed, L. H., *Jour. of Med. Research*, Vol. 31, 1914.

[3] Streeter, G. L., to be published in the "Proc. of the Amer. Asso. of Anat.," 1916.

reason that I believe it to be essentially different from the method of formation of blood-vessels.

Again in the eye there are two cavities having an entirely different development. Posterior to the lens is a space filled with fluid, which begins not by a hollowing out of tissue-spaces in mesenchyme, but as a definite differentiation of a primitive vitreous body by the retina. In the formation of this body the mesenchyme is only secondarily concerned. On the other hand, the history of the aqueous chamber of the eye is analogous to that of the formation of the cerebro-spinal system of tissue-spaces.

Along the pathway of the blood-vessels of the central nervous system are special chains of tissue-spaces, lined by an indefinite mesothelium, but arranged in sufficiently definite lines to have received the name of peri-vascular lymphatic spaces. These spaces, however, have no relation to lymphatics and should be called perivascular tissue-spaces. Along the nerves also are chains of spaces which can be injected in the embryo, and which may be termed perineural spaces. Similar chains of connecting spaces have been injected by Lhamon[4] along the course of the Purkinje fibers of the heart. Besides these very interesting special systems of tissue-spaces there is a group of great spaces which is still better known—namely, the great serous cavities of the body. These cavities, which form as a dilatation of spaces in the mesenchyme, have also a definite embryological history, a definite cellular wall of mesothelium, and a special very scanty content of fluid.

In order to analyze the relation of the general tissue-spaces and of these special systems of large tissue-spaces which develop out of the general ones, it is necessary to submit them all to some type of experiment. Fluids containing a suspension of minute granules or true solutions whose location can be detected subsequently by the precipitation of granules injected into these various spaces give widely and astonishingly different results. Weed has carried out a very interesting series of experiments of injections into the subdural and subarachnoid spaces. In these experiments he injected a solution of potassium ferrocyanide and iron ammonium citrate, at the same time withdrawing an equivalent amount of cerebro-spinal fluid, to eliminate phenomena due to pressure. He found that when the granules of Prussian blue were precipitated by an acid-fixing agent, they were in the meshes of the arachnoidal villi, within the cells of the nests of mesothelium at their tips and within the dural sinuses. On the other hand, when he produced a cerebral anemia by bleeding, the fluid was sucked into the special and very important tissue-spaces that surround the nerve-cells. These experiments demonstrate conclusively that the central nervous system has a special system of tissue-spaces beginning, one might say, with the spaces surrounding every individual nerve-cell of the brain, extending into the subarachnoid area and draining not by lymphatics, but by another special system of absorbents—namely, the arachnoidal villi—into the cerebral sinuses. Wegefarth[5] has shown that the anterior chamber of the eye has a similar system of absorbents, the pectinate villi. These lead to the canal of Schlemn, a vein analogous to the cerebral sinuses.

When injections are made into the peritoneal cavity the results vary widely, according to the nature of the fluid injected. As a matter of fact our knowledge of this important subject is far from complete, but it has been shown that certain true solutions are absorbed by the blood-vessels. On

4 Lhamon, R. M., *Amer. Jour. of Anat.*, Vol. 13, 1912.

5 Wegefarth, P., *Jour. of Med. Research*, Vol. 31, 1914.

the other hand, it is known that granules are in large part taken up by special large phagocytic cells, some of which pass into the lymphatics of the diaphragm. This gives a suggestion of a possible differentiation in absorption between blood-vessels and lymphatics. Indeed, a partial differentiation in function is a most familiar phenomenon: I refer to the villi of the intestine, where almost all of the fat passes into the central lacteal while the carbohydrates pass directly into the blood-stream. It is well known, on the other hand, that when a needle is introduced into certain areas under the skin or into specific layers of many of the organs and a fluid containing granules is injected, the granules always appear in the lymphatic trunks which drain the area. What is the difference between tissue-spaces which are drained by lymphatics and those which are not? What is the difference between areas in which injections always show lymphatics and those which never show lymphatics? What is the nature of the fluids which pass through the lymphatics and those which do not? In other words, exactly what happens at the point of the needle when an artificial edema is produced? This I understand to be the meaning of the main problem connected with the lymphatic system—the solution of the enigma of the mechanism of absorption. The difficulty of the problem was well expressed by Bartels[6] as late as 1909, when he said that the relation of the lymphatic capillary to the tissue-spaces was a philosophical rather than an anatomical problem. My understanding of the recent work on the lymphatic system is that it tends to take the system out of the realm of the mythical and to make it a definite anatomical entity. The investigations of the last fifteen years have demonstrated that the blood-vessels are the primary absorbents, and that subsequently partial systems of absorbents develop, such as the arachnoidal villi and the lymphatics which drain into the veins.

I have been greatly interested in the attempts of the earlier anatomists to solve the problem of absorption. They brought to the subject of tissue-spaces and the fluid within them a great freshness of interest and constantly sought to understand the meaning of their various observations. They saw the arteries become smaller and smaller, they were familiar with lymphatic trunks and with some lymphatic capillaries. What then was more natural than to assume that when the arterioles became so small that the corpuscles could not enter, there were still smaller vessels which carried the plasma over into the lymphatics? These tiny hypothetical vessels were called "vasa serosa." A belief in their existence was held throughout the eighteenth century, and was not overthrown until the discovery of cells by Schwann in 1830. Schwann believed that the mesenchymal cells were hollow and from this idea Virchow formulated the theory that hollow connective-tissue cells spanned the gap between the blood-vessels and the lymphatics. Then followed the discovery by von Recklinghausen that the wall of the lymphatic capillary was composed of cells. Von Recklinghausen thought that silver impregnations showed that lymphatics spread out as lymph radicles or lymph rootlets into the tissue-spaces. At first His believed in these lymph radicles, that is, in open lymphatics, but von Recklinghausen's discovery of endothelium led him to a conception of a lymphatic capillary as a definite, closed vessel, this conception being confirmed by his own experience with injections. If lymphatics open out into tissue spaces every injection of a capillary plexus with a non-

[6] Bartels, P., "Das Lymphgefässystem. Handbuch der Anatomie des Menschen," Von Bardeleben, 1909.

diffusible fluid should spread out into tissue spaces and obscure the vessel—which is most obviously not the case. Thus von Recklinghausen's discovery served to bring up anew the question of open and closed lymphatics.

During the present century it has become evident that some light might be thrown on the obscure question of the relation of tissue spaces to lymphatic capillaries through the study of their development. The first general hypothesis concerning the origin of the lymphatic system in the embryo was that fluid exuded from the peripheral blood-vessels and gradually hollowed out channels. As the fluid increased, these vague channels were thought to extend from the periphery to the center and then establish connections with certain veins. This hypothesis was made concrete by Gulland,[7] who found large empty vessels in the skin of embryos about 4 cm. in length, which he thought to be the first lymphatics. In reality the lymphatics begin much earlier. This general hypothesis was to some extent modified by studies of Budge[8] and Sala.[9] Budge injected the extra-embryonal celom in early chick-embryos, and got patterns of injection in the area vasculosa vaguely simulating lymphatics. These patterns we now know were produced by fluid passing out of the celom into the network of spaces between the plexus of blood-capillaries. Budge then made beautiful injections of true lymphatics in much later stages, and to explain his observations built up the hypothesis that there was a primitive lymphatic system associated with the body cavity and a later, secondary system of definite ducts. The thoracic duct he believed formed the connection between these two systems. These observations of Budge, which we now know to be incorrect, are, however, of great interest to the embryologist—representing as they do the earliest groping in darkness in hope of finding the first lymphatics. The work deserves emphasis also as the only basis of all the erroneous theories surrounding the idea that the body cavity is in some especial way a part of the lymphatic system.

Another very interesting attempt to find the first lymphatics is shown in the work of Sala, who studied the origin of the posterior lymph-hearts in the chick. We know now that these lymph-hearts arise as endothelial buds from the walls of the coccygeal veins and that these buds develop into a plexus, which becomes a pulsating lymph-heart. Sala, working with this rapidly developing plexus, somewhat vaguely appreciated its relation to the veins: he described a hollowing out of cavities in the mesenchyme near the veins and then said that in the last analysis these cavities in the mesenchyme were from their first appearance nothing but terminal dilatations of the veins. However, he concluded that the lymphatics begin as excavations in the mesenchyme which soon join the veins. The confusion in Sala's description is now easily understood. Dominated by the theory that lymphatics were tissue-spaces, he could not analyze the evidence that they were from the start connected with the veins, and so described them as both veins and tissue-spaces. He made it clear, however, that he believed that the ducts were formed from chains of tissue-spaces hollowed out in the mesenchyme and lined by flattened-out cells. Sala's work, however, places the first lymphatics close to the veins, and demonstrates the difficulties of relying on the interpretation of sections in unraveling problems of growth.

Sala's work was published in 1900, and

7 Gulland, *Jour. of Path. and Bact.*, Vol. 2, 1894.

8 Budge, A., *Arch. f. Anat. u. Phys.*, Anat. Abth., 1887.

9 Sala, L., *Ricerche Lab. di Anat. Norm. d. r. Univ. di Roma*, Vol. 7, 1899–1900.

during that year I was working on the development of the lymphatic system.[10] I began the investigation by injecting the foot-pads of young pig embryos. This procedure never fails to demonstrate lymphatics in the adult, and the same is true of fetal stages, but it was soon found that in embryos less than 3 cm. in length it was necessary to introduce the needle nearer the central veins in order to find lymphatics. By a long series of such injections the fact was gradually established that the skin of the embryo is invaded by lymphatics from two general regions—the neck and the groin. By noting the lines of growth of these invading vessels it was possible to obtain injections, showing the extent of the invasion of the skin for each stage. Moreover, in making these injections into the translucent skin of the embryo it became evident that in order to fill the lymphatics the needle must be introduced at a very exact level. When the needle cuts the lymphatics, the vessels can be seen to fill up from the oblique opening of the needle, without any extravasation if the pressure is light. If the needle is entered too superficially a bleb is always formed: if too deeply, the injection mass spreads out in straight lines, very characteristic and very different from lymphatics. These observations emphasize the lymphatic capillary as a definite vessel located at a specific level. Through a long series of such injections these definite lymphatic vessels were traced back to tiny buds close to the veins. The theory was then advanced that the entire lymphatic system consists of definite vessels of endothelium, which grow as blind buds from the endothelium of the veins and partially invade the body. The theory throws the emphasis on endothelium as the essential tissue of the lymphatic system, and premises that the endothelium of the lymphatic system is derived from the endothelium of the veins. This means that lymphatic vessels arise as an active growth of endothelial cells and are not formed by a passive dilatation of spaces. The outgrowth theory has not been established without opposition. There has been, indeed, a vigorous effort in this country to re-establish the older hypothesis of the origin of lymphatics from tissue-spaces, but in my judgment these efforts have not been successful.

I shall now outline briefly certain facts which have been established concerning the development of the lymphatic system. The lymphatic system begins in the human embryo of about 10 mm. in length—that is, during the sixth week of development. The first lymphatics are blunt buds which come from the internal jugular veins at the root of the neck. They are filled with blood which backs into them from the vein. These buds soon establish connections with each other and form a plexus which develops into a large sac, having its base on the internal jugular vein and arching into the posterior triangle of the neck. From this sac, which is astonishingly large, lymphatics grow out to the skin of the head and neck, to the thorax and arm, and partially invade the deep structures of the head. From the portion of the sac in the posterior triangle of the neck, vessels grow forward and form an extensive plexus along the external jugular vein. The knowledge of the form of this sac, of its position with reference to the internal jugular vein, and the pattern of the plexuses which develop from it, has unraveled the complicated and puzzling relations of the lymphatic ducts to the chains of lymph glands in the neck. The sac itself is transformed into different groups of lymph glands which might be analyzed as the primary lymph glands of

[10] Sabin, F. R., Johns Hopkins Hospital Reports, Monographs, New Series, No. 5, 1913. Gives a list of the literature.

the neck, and these primary lymph glands bear a definite relation to the secondary glands which form along the ducts growing out from the sac.

At a slightly later stage—in embryos of the seventh week, approximately 20 mm. in length—a series of lymphatic buds develop from some of the abdominal veins. These early buds have proved more difficult to study than the jugular buds—first because the veins from which they arise are more complex and were less well known, and secondly because their deep position has made direct observation in the living embryo and direct, precise injections practically impossible. Therefore our knowledge of the extent and origin of the abdominal lymphatics from different veins is still far from complete. Certain very interesting observations by Silvester[11] on monkeys and by Job[12] on rats show that in these forms certain lymphatic ducts drain permanently into the inferior vena cava, the iliac, the renal or the portal veins, suggesting a multiple origin of lymphatics from the abdominal veins. The main abdominal lymphatics begin as a retroperitoneal sac which develops from a vein connecting the two Wolffian bodies. This vein ultimately forms a part of the inferior vena cava. This large retroperitoneal sac furnishes the key for the study of the abdominal lymphatics. The lymphatics of the skin of abdomen and for the legs grow from paired iliac sacs. The retroperitoneal sac and the paired iliac sacs become connected with the left jugular sac by means of the thoracic duct, which grows from the left jugular sac and from the abdominal lymphatics, and is complete in embryos about 25 mm. long. There is thus formed a primary lymphatic system of sacs connected by the thoracic duct; this system in most mammals drains into the internal jugular veins on either side. From the primary sacs, a plexus of capillaries invades the body. In a general way, the vessels from the jugular sacs grow to the head, thorax and thoracic viscera; those from the retroperitoneal sac to the abdominal viscera, and in part to the thoracic viscera; and those from the iliac sacs to the abdominal walls and legs.

The injection of these invading plexuses of lymphatics from the sacs outward is possible in the embryo, though it is impossible in the adult, owing to the fact that the early vessels are without valves. In a general way it may be stated that by the time a fetus has reached the length of 5 cm. almost the entire skin has been invaded by a single plexus of lymphatic capillaries and the organs have received their primary lymphatic vessels. At this stage of embryonic development injections of any part of the lymphatic plexus spread out in all directions, so that theoretically the injection of any capillary might fill the entire system. I have injected the thoracic duct, for example, from the skin of the thorax, the injection mass passing around through the iliac lymphatics; or again I have injected the lymphatics of the skin by puncturing the thoracic duct. This complete anastomosis of the primary lymphatic capillary plexus of both the superficial and the deep systems in the embryo seems to me to be of considerable importance.

To illustrate the development of the lymphatic system to an organ and without an organ, I shall describe Cunningham's[13] work on the lymphatics of the lung. He has found that lymphatics approach the lung from three sources—from the two jugular sacs there are right and left lymphatic trunks and from the retroperitoneal sac

[11] Silvester, C. F., *Amer. Jour. of Anat.*, Vol. 12, 1911–12.

[12] Job, T. T., *Anat. Record*, Vol. 9, 1915.

[13] Cunningham, R. S., "Proc. Amer. Asso. of Anat.," *Anat. Record*, Vol. 9, 1915.

there are vessels which come up behind the diaphragm. The ducts which grow down from the neck meet in a plexus which surrounds the trachea. In the primitive lung, the general pattern of the organ is simple; it is obviously blocked off into large lobules by wide connective tissue septa. In the center of each lobule are the bronchus and the artery, in the septa are the veins. At the hilum the tracheal lymphatics divide into three plexuses, one spreading on to the pleura, a second following the bronchi and arteries, and the third the veins. The plexus which follows the veins grows rapidly to the pleura and spreads around the border of each primitive lobule, blocking off the pleura into polygonal areas. From this pattern the pleural lymphatics develop. The pleura is blocked off into its polygonal areas by the lymphatics when the embryo is about 5 cm. in length. At a much later stage, when the bronchi begin to develop atria and air sacs at their tips, the lymphatics grow down the center of the lobule along the bronchi. Just where the atria begin, the lymphatics turn sharply from the bronchi and pass out to the septa, so that the walls of the air sacs are without lymphatics.

The lymphatics of the diaphragmatic surface of the pleura grow up behind the diaphragm from the retroperitoneal sac, and injections of this surface of the lung in later stages fill up the pre-aortic, abdominal lymph glands. This relation of the pleural lymphatics to the abdominal lymphatics I believe to be of importance.

The development of the ducts to the intestines, and their differentiation within the intestinal wall into the ultimate lacteals of the villi, have also been worked out. The method of injection in the embryo affords an exeellent opportunity to test the present belief in the partial invasion of organs by lymphatic vessels. For example, lymphatics have not been demonstrated in the adult liver beyond the capsule and the connective tissue septa, nor in the spleen beyond the capsule. It is well known that lymphatics are abundant in tendons; but they have not been demonstrated in striated muscle. On the other hand, it has been definitely shown, both in the embryo and in the adult, that there are no lymphatics in the central nervous system.

To this very general account of the lymphatic system in the mammal certain interesting facts from comparative anatomy must be added. It has long been known that there are pulsating lymph hearts in the amphibia. These lymph hearts arise as lymph sacs from the vertebral veins in the neck and from the coccygeal veins at the root of the tail. These sacs are close to the myotomes and develop striated muscle in their walls. In the birds there is a very interesting lymphatic system. There is a jugular lymphatic plexus which later becomes a lymphatic gland, and a caudal pulsating lymph heart, which develops from the coccygeal veins. In mammals the lymph sacs develop into groups of lymph glands, which may be called the primary glands for each region, while secondary glands develop along the lymphatic ducts.

In this brief résumé of the lymphatic system I have given only facts which can be clearly demonstrated. There are these sacs against the veins, and if injections are made from them one can demonstrate a gradually increasing plexus of vessels. These facts, however, but lead us on to seek their meaning. What are lymphatic capillaries, how do they arise, and how do they grow? There is general agreement that the lymphatics arise from certain centers and grow toward the periphery; but there are two theories as to how they grow. The theory which I hold is that the lymphatics arise from the endothelium of the veins and

grow by the multiplication of endothelial cells. The opposing theory holds that the lymphatics arise from tissue-spaces and grow by adding on new tissue-spaces; that beyond the tip of a definite completed vessel, which can be injected, are tissue-spaces which will be added to the capillary.

It is here necessary to submit the different types of method and the nature of the evidence which has been brought forth under the stimulus of these two theories. Some of the methods are direct, some indirect, but in all there is an effort to understand the nature of that very interesting and important tissue, the endothelial cell.

First, in regard to the nature of the earliest lymphatic buds, it is clear from sections, both of mammals and of birds, that these buds are lined by endothelium, but it proved very difficult to determine from sections that these buds were from the beginning connected with the veins. Eleanor Clark,[14] however, was able to test this point in the case of the lymphatics of the chick by developing a method for observing the tiny red buds in the living embryo. Into these lymphatic buds she injected a few granules of ink, and then observed the granules entering the vein. Moreover, in the amphibia Fedorowicz[15] has traced each step of the origin of the lymphatic buds from the veins, by specific differences between the endothelium and the mesenchyme.

From these early lymphatic buds it is possible to inject an increasing plexus of lymphatic capillaries as the embryo develops, and by this method to follow the lymphatic capillaries to their form in the adult, in the few places where that form is known. On this evidence was based the theory of the centrifugal invasion of the body by lymphatic capillaries. The next method of study which occupied the attention of the group of anatomists who were trying to follow the development of the lymphatic system was a comparison of the adequacy of the method in injection with the adequacy of the method of reconstruction of lymphatics from serial sections as applied to the problem of growth. This long series of studies followed an observation of Lewis[16] that if the lymphatics were reconstructed from sections they would appear as isolated vesicles for which no connections could be found. This is the experience of all who attempt to reconstruct an uninjected capillary plexus from sections, and therefore it has been necessary to test the limitations of the method. It is claimed that the method of reconstruction reveals more lymphatics than can be shown by the injection method, as it shows not only all the lymphatics which can be injected, but also the spaces that will be added to the plexus later. Moreover, it is on the evidence of reconstructions that the theory of the growth of lymphatics by the addition of tissue-spaces is based. It is true, of course, that injections would not fill up solid sprouts of endothelium, and everyone who has made injections of lymphatics is familiar with the difficulties of obtaining perfect specimens, but it has been demonstrated that when an area is chosen which can be adequately injected, more of a capillary plexus can be shown than can be reconstructed. For example, Eleanor Clark[17] has published a picture of an injection of the jugular lymphatic plexus of a chick which showed a far more extensive plexus than was demonstrated in a reconstruction of the same stage, previously recorded by Miller.[18] The two pictures, side by side,

[14] Clark, E. R. and E. L., *Anat. Record*, Vol. 6, 1912.

[15] Fedorowicz, S., *Bull. d. l'Acad. d. Sciences d. Cracovie*, 1913.

[16] Lewis, F. T., *Amer. Jour. of Anat.*, Vol. 5, 1906.

[17] Clark, Eleanor L., *Anat. Record*, Vol. 6, 1912.

[18] Miller, A. M., *Amer. Jour. of Anat.*, Vol. 12, 1912.

afford a striking contrast. The amount of the plexus which can be demonstrated by reconstruction increases very much if an oil immersion lens is used, but the method, though one of the most important aids in embryology, is entirely inadequate to test the method of growth of capillaries. No one would regard it as adequate to determine an entire plexus of blood capillaries even where their pattern is well known.

It is, I think, obvious that the only adequate method for the study of the growth of capillaries is to observe them in a living specimen; and in this connection we have a long series of valuable observations on the classical object, the living tadpole's tail. Capillaries were first seen in the tadpole's tail by Schwann, and were first differentiated into two types, blood-capillaries and lymphatic-capillaries, by Kölliker. During a long series of studies with this object, by Remak, Sigmund Meyer and others, and finally by Eliot R. Clark,[19] with greatly improved methods, two facts have become established—first, that endothelium is contractile and second that the vessels grow by the cell division of their own walls. Clark was able to watch a given lymphatic for several days and to observe that the wall put forth tiny processes of protoplasm, which we term sprouts, that the nuclei of the cell divided and wandered into the new sprouts, which developed into new vessels. He was able to plot out every mesenchymal cell in the neighborhood and to show that the growing sprouts of endothelium avoided rather than approached the processes of mesenchyme, and never incorporated them into their walls. Thus in the one place where natural conditions are such that every cell, or rather every nuclear area of a growing vessel, and every mesenchymal cell can be identified, it is without question true that both blood-capillaries and lymphatic capillaries grow through the proliferation of their own walls.

[19] Clark, E. R., *Anat. Record,* Vol. 3, 1909. *Amer. Jour. of Anat.,* Vol. 13, 1912. "Proc. Amer. Asso. of Anat.," *Anat. Record,* Vol. 8, 1914.

The method of growth of capillaries may thus be regarded as established. But this is not the whole problem for the embryologist. Under development he must consider both the original differentiation of tissues and their method of growth. In embryology it has become clear that there is a gradual differentiation of tissues from a common cell mass, and that after a tissue is once differentiated it increases by cell-division. This conception of the differentiation of tissues was clearly stated by von Baer in 1828. He called the process histological differentiation. Thus, development consists in the differentiation of tissues followed by growth. The most recent work on the lymphatic system demonstrates that the period of differentiation of endothelium is the period of the origin of the blood-vessels, and that this period has long since passed when lymphatics begin. Lymphatics do not differentiate from mesenchyme, but grow from veins.

It is well known that methods have long been sought by histologists to distinguish endothelium from mesenchyme. If we could always distinguish endothelium in sections the problem would be practically solved, but the difficulty of determining lymphatic endothelium in the sinuses of lymph glands, or vascular endothelium in the spleen pulp are too well known to need emphasis. These very difficulties lead us to the question, is endothelium differentiated from mesenchyme?

Efforts to distinguish endothelium from mesenchyme have not been entirely without results. For example, Clark has found that in the chick the nuclei of lymphatic endothelium can be distinguished from the nuclei of the mesenchyme by characteristic

nucleoli. Again Kampmeier[20] has shown that both venous and lymphatic endothelium in the toad can be distinguished from mesenchyme at certain stages by the presence of a greater number of yolk globules. Indeed, this differentiation of vascular and lymphatic endothelium from the mesenchyme was so striking as to convince Kampmeier that the lymphatics arose from the veins, though he had previously held the view that they arose from tissue-spaces.

These observations, valuable as they are, are not sufficiently universal to determine the nature of endothelium. The lymphatic endothelium grows from the endothelium of the veins; but since it varies slightly from the venous endothelium we may say that it is secondarily differentiated from it. This idea leads us directly to the most fundamental problem connected with the entire vascular system—namely, how does endothelium arise, how do the first endothelial cells differentiate? The question of the origin and the growth of the lymphatic system will not be completely solved until its essential tissue endothelium is completely understood. This leads us to seek for the origin of the first blood-vessels.

The question of the origin of the heart and blood-vessels has a vast literature. Since the time of Wolff and Pander, it has been known that blood-islands in the chick arise in the wall of the yolk sac. Then His[21] discovered that blood-vessels arise by a differentiation of vaso-formative cells or angioblasts. This is the fundamental point which recent work confirms, His having proved that angioblasts differentiated in the wall of the yolk-sac, and having seen that they did invade the embryo, advanced the hypothesis that all the angioblasts differentiated in the yolk-sac and then invaded the body from the embryonic membranes. The theory regarding angioblasts thus became centered around the idea of this invasion, and the more fundamental point was obscured. In recent years this theory that all of the vessels of the embryo are derived from the vessels of the membranes has been disproved by certain experiments of Hahn.[22] Hahn selected chicks in the stage of the primitive streak and burned out the membranes opposite the posterior end of the streak. In a few specimens which lived he found a small aorta and cardinal veins on the injured side of the embryo. These results have been confirmed by Miller and McWhorter[23] and by Reagan[24] on the chick and again by studies on the fish embryo by Stockard.[25] It may thus be regarded as proved that blood-vessels arise both within the embryo and in the embryonic membranes.

Stockard then went on to attack the more fundamental problem, how does endothelium first arise? In studies made on the yolk sac of the living fish embryo, he found that endothelium arises as spindle cells which differentiate out of mesenchyme. Moreover, he found that the endothelial cell was distinct from the blood-cell. This confirmation of the angioblast of His I regard as a very important contribution.

It is very clear in following the work of His, that he made studies on the living blastoderm of the chick, but so far as I am aware McWhorter and Whipple[26] were the first to study the living blastoderm of the chick in a hanging-drop preparation. By

20 Kampmeier, O. F., *Amer. Jour. of Anat.*, Vol. 17, 1915.

21 His, W., Untersuchungen über dir erste Anlage des Wirbelthierleibes, Leipzig, 1868.

22 Hahn, H., Arch. f. Entwicklungsmechanik der Organismen, Bd. 27, 1909.

23 Miller and McWhorter, *Anat. Record*, Vol. 8, 1914.

24 Reagan, F. P., *Anat. Record*, Vol. 9, 1915.

25 Stockard, C. R., *Amer. Jour. of Anat.*, Vol. 18, 1915. Two articles.

26 McWhorter and Whipple, *Anat. Record*, Vol. 6, 1912.

using this method, I find, just as did His, that blood-vessels begin by a differentiation of cells. It is difficult to be sure of the first cells in the living chick which become angioblasts, but by the time the first cleft appears which indicates the position of the two upper myotomes there is an extensive plexus of bands of cells in the area vasculosa. In watching these bands of cells in the living specimen, I thought for some time that they could be differentiated by a slightly greater refractility than the rest of the tissue; but this did not prove to be an adequate criterion, for when the syncytium of mesenchyme forms in the later stages it makes a network of the tissue which is just as refractile. Moreover, in the study of the early vessels in the living blastoderm it is extremely difficult to tell which is the vessel and which the interspace. However, I found that the bands of endothelium or the definite vessels which form from them would suddenly change their appearance over wide areas, becoming intensely refractile and very granular and opaque. In this stage, which is so striking that it can be seen under low powers of the microscope, the vessels lose all appearance of being hollow; and I soon found that this was because every cell was passing into the phase of cell-division. This was proved by the rows of spindles in stained specimens.

The extent of cell-division in these chick embryos is most interesting. At times wide areas of the endoderm cell divide and become so opaque as to entirely obscure the cells beneath, and one has to wait until the endoderm becomes clear again. The difference in the reaction of the bands of endothelium and the syncytium of mesenchyme to cell division is a guide in the study of the early differentiation of blood-vessels. When the bands of endothelial cells divide the cells remain together: the outline of each cell becomes distinct, but they do not separate. In the case of the division of the cells of a syncytium of mesenchyme, however, many of the processes are withdrawn and the cell-body rounds up, so that it stands out as if it were an isolated cell, as has been described by Margaret Reed Lewis in tissue-cultures. Thus in areas in which it becomes very difficult to trace the ultimate strands of endothelium it may be necessary to wait for the phase of cell-division in one or the other tissue in order to make the distinction. In watching the vessels of the area vasculosa, one gets the suggestion that there may be a rhythm in cell-division. For example, if the area pellucida around the posterior end of the embryo be considered as divided into an inner and an outer zone, either all the vessels of the inner zone or all those of the outer zone may be found in cell division at the same time.

The vessels of the original plexus increase in size by cell division and new vessels are constantly formed within the plexus by numerous sprouts that grow out to connect its meshes. Beside this growth within the plexus there is an active differentiation of new endothelial cells, which can be watched in the living chick. In the early stages, up to five or six somites, there is no syncytium of mesenchyme and the wandering cells are scanty in number. Individual spindle-cells are thus clearly seen. They divide and at once show the essential characteristic of endothelium—that is, the tendency to form bands. Either an individual cell, or bands of two or three cells, send out tiny processes toward the older bands of endothelium, which at once respond by sending out tiny processes to meet the new ones. Thus endothelium consists of cells which differentiate as spindle-cells from the mesenchyme, and show at once two characteristics, first a tendency to remain

together after cell-division forming strands, and secondly, a tendency to join other bands of similar cells by protoplasmic processes. These bands of cells become blood vessels.

It is, I think, clear that the question now to be solved is how long does endothelium continue to differentiate out of mesenchyme? It can be seen to differentiate in the living chick in all the stages I have yet studied, that is in the stages before the circulation is established. This covers approximately the first two days of incubation. As is well known, there is a group of anatomists—Maximow, Reichert and Mollier, and a group of American workers, notably Huntington and McClure, who believe that endothelium continues to differentiate out of mesenchyme possibly throughout life. From the evidence which I have previously given I think it much more likely that endothelium will prove to have a limited period of differentiation, followed by growth. The study of the origin of blood-vessels seems to me to emphasize again the endothelial cell and to show that the vascular system arises from a differentiation, and growth of endothelial cells rather than by a dilatation of spaces.

In looking back over the history of the development of our knowledge of the lymphatic system, it is very clear that there have been periods of great activity followed by periods of rest. We are at present in a period of activity, and I should like to sum up what seem to me to be the results of the work of the last fifteen years. It has been shown that the problem of the origin of the lymphatic system is but a part of the general problem of the origin of the vascular system. Lymphatics are modified veins, in the sense that they grow from the veins. The veins are the primary absorbents and continue to take part in absorption throughout life. Up to the time of about six weeks for the human embryo, they are the only absorbents. Subsequently other systems develop, such as the arachnoidal villi and the lymphatic vessels, to assist in the function of absorption. The lymphatics only partially invade the body, and present indications point to the fact that their functions in absorption may be to some extent specific.

In an injection into the tissues of a dead organism it is essential to puncture the vessels of a plexus of lymphatic capillaries in order to fill lymphatics with a non-diffusible fluid. These injections demonstrate a complete wall, in the anatomical sense, which is ruptured only by increased pressure. In the living animal both true solutions and granules pass into lymphatic capillaries through the activities of endothelial cells or by means of wandering phagocytic cells.

This conception of the lymphatic system is at variance with the older idea of hazy lymphatic capillaries that faded off indefinitely through hypothetical lymph radicals into the tissue spaces. With the newer conception of definite lymphatic capillaries of endothelium it would be much better if we should revise the terms which developed in the period when our theories were vague and indefinite. In the first place there are "blood-capillaries," "lymphatic capillaries" and "tissue-spaces." If we should reserve the term "plasma" for the fluid within the blood-vessels, "lymph" for the fluid within the lymphatics and "tissue-fluid" for the fluid within the tissue-spaces, it would be a great gain in clearness. The term "tissue-fluid," meaning the fluid which is in the tissue-spaces of the living animal, should not be confused with the term "tissue-juice," by which the physiologist means the fluid which can be pressed out of the tissues. The term tissue-fluid should include such

special fluids as the cerebro-spinal fluid, the aqueous humor and the fluids of the serous cavities, as well as the general fluid of the less specialized tissue-spaces.

The study of the lymphatic system throws emphasis on the importance of tissue-spaces. I am convinced that the understanding of lymphatic capillaries as definite structures, definitely placed in restricted areas, forms a secure basis from which the varied problems of absorption may be solved.

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The Johns Hopkins University

STATISTICAL PHYSICS[1]

Every physical measurement must be made in a region in equilibrium,[2] and nearly all of the correlations which have been established in physics, that is, nearly all physical laws, relate to substances in steady states or to substances in equilibrium. Furthermore, nearly all physical laws are one-to-one correspondences, and they are expressible as analytical functions. Thus the pressure of a given amount of a gas is an analytical function of the volume and temperature of the gas.

In every field of measurement, however, extreme refinement and care lead an investigator into a region of erratic action. This is evident when we consider that refined measurements are always subject to erratic error, and the atomic theory of the constitution of matter suggests that erratic action is always present everywhere, even in substances in complete thermal equilibrium.

[1] The substance of a lecture delivered by W. S. Franklin before the Department of Terrestrial Magnetism of the Carnegie Institution, Washington, D. C., December 20, 1915.

[2] Thermal equilibrium is here referred to; certain quasi states of thermal equilibrium being included. The only exception is the kind of measurement which consists of simple counting, like the counting of cattle as they pass through a gate or the counting of electrons as they enter an ionization chamber.

It has long been the custom to speak of the probable error of a precise measurement *as if perfect precision would be possible if our measuring devices were perfect and free from erratic variations.* It is important, however, to recognize two distinct types of erratic error, namely, *extrinsic error* due to uncontrollable variability of the measuring device or system, and *intrinsic error* due to inherent variability of the thing or system which is being measured. Every physical measurement involves an operation of congruence, a standard of some kind is fitted to or made congruent with successive parts (which parts are thereby judged to be equal parts) of the thing or system which is being measured; and the standard system and the measured system are both subject to erratic variations.

There is, perhaps, no case in which intrinsic error and extrinsic error can be clearly distinguished and separated from each other; but when the errors of one kind are much larger than the errors of the other kind they can, of course, be recognized. It is proper to speak of the *probable error* of a single measurement when the variations of the measuring device or system are dominant, but one should speak of the *probable departure* of the measured system from a certain mean condition at any time when the "errors" of observation are due chiefly to variability of the thing or system which is being measured. Thus in measuring the coefficient of sliding friction extrinsic error may be made negligible by making the measurements carefully, but very large "errors" persist. The thing which is being measured is inherently indefinite, and it may at any time depart widely from its average value.[3] In measuring the loss of

[3] A very brief but comprehensive statement of the proper precision method for the study of an erratic thing like friction is given by W. S. Franklin, *Transactions of American Institute of Electrical Engineers*, Vol. 20, pp. 285–286.

head in a water or gas pipe systematic errors (due to the particular details of roughness, etc., in the pipe) are not in evidence when a particular pipe is used, and extrinsic errors may be made negligible by using a precision device for measuring pressure; but the loss of head (or pressure) remains nevertheless extremely variable on account of eddy action which grows out of unstable vortex sheets; that is to say, very large "errors" persist, the thing which is being measured is inherently subject to erratic variation.

DESCRIPTIVE SCIENCE AND STATISTICAL SCIENCE

The greater part of physical science as applied in the arts and as used by the investigator is essentially descriptive. Thus we may wish to determine how the members of a bridge stretch or shorten as a car passes across the bridge; how electromotive force, current strength and all the changing variables play in the operation of a dynamo; how the pressure and temperature of the steam vary during the successive stages of admission, expansion and exhaust of a steam engine; and so on. But everything that takes place in this world has associated with it a substratum of complex action which baffles description. Consider, for example, a simple thing like the movement of a train of cars. The engineer is concerned only with certain broad features of what takes place, the amount of coal and water used, the draw-bar pull of the locomotive, and the forward motion of the cars as affected by steepness of grade, and the opposing force of friction. But who could describe in detail the rocking and rattling motion of the cars and the whirling and eddying motion of the surrounding air, and who could trace the motion of every particle of dust and smoke! This indescribably complex action we call by the name of *turbulence*—it exists everywhere and in everything that goes forward in this world of ours, and it is never twice alike in detail even when the conditions are what one would consider exactly the same. All of which suggests two postulates concerning turbulence, namely (*a*) that it is infinitely[4] complicated, and (*b*) that it is essentially erratic in character. Let it be understood, however, that we are not speaking in terms of ordinary values in making these two statements. It is not a question, for example, as to whether a brakeman loses his hat every time he makes a trip from Albany to Buffalo, but it is a question as to whether his hat is lost every time at identically the same place because of a gust of wind of precisely the same character when he lets go of it in the same way because of a sudden jerk of the train which always occurs at the same place in exactly the same manner, and so on in endless detail of specification—if such specification were possible!

In the motion of a simple mechanism like the sun and planets, or in the operation of a simple machine like a dynamo the accompanying erratic action is practically negligible. Thus one does not consider even the tremendous storm movements in the sun in the study of planetary motion, and one does not consider the minute details of the motion which takes place in a lubricated bearing in the study of the operation of a dynamo. In many phenomena, however, erratic action is dominant, and in the study of such phenomena the statistical method must be used. Consider, for example, the motion of the water in a brook. This motion presents a fairly definite average character at each point, and a fairly typical rhythmic variation from this average exists at each point, but there is an erratic depar-

[4] The idea of infinity which comes from counting, one, two, three, four and so on *ad infinitum*, is as nothing compared with the intimation of infinity that comes from things that are seen and felt!

ture from this regular motion which is by no means negligible in magnitude. So it is, in the case of the weather. There is a fairly definite average of weather conditions at a place from year to year, and a fairly typical rhythmic variation, but there is an erratic departure from average and from type, and this erratic variation of the weather can only be studied statistically.

Turbulence is characteristic of those physical and chemical changes which are called irreversible or sweeping processes.[5] The most familiar example of such a process is ordinary fire, and, as every one knows, a fire is not dependent upon an external driving cause, but when once started it goes forward spontaneously and with a rush. It is not, however, exactly correct to speak of a fire as *spontaneous*, because this word refers especially to the beginning of a process, whereas we are here concerned with the characteristics of a process already begun. Therefore it is better to describe a phenomenon like fire as *impetuous* because it does go forward of itself. Tyndall, in referring to the impetuous character of fire, says that it was one of the philosophical difficulties of the eighteenth century. A spark is sufficient to start a conflagration, and the effect would seem to be out of all proportion greater than the cause. Herein lay the philosophical difficulty. This difficulty may seem to be the same as that which the biologist faces in thinking of the small beginnings of such a tremendous thing as the chestnut-tree blight in the United States. The chance importation of a spore is indeed a small thing, but it is by no means an infinitesimal, whereas, under conceivable conditions a fire can be started by *a cause more minute and more nearly insignificant than anything assignable*. This possibility of the growth of tremendous consequences out of a cause which has the mathematical character of an infinitesimal is the remarkable thing; and this possibility is not only characteristic of fire, but it is characteristic of impetuous processes in general.

[5] There is one type of irreversible process which is steady and amenable to measurement while under way, namely, the so-called steady sweep.

STATIC AND DYNAMIC INSTABILITY

Impetuous processes, such as storm movements of the atmosphere, are intimately connected with conditions of instability. Indeed, an impetuous process seems always to be the collapse of an unstable state. Let us consider, therefore, two ideal cases where the condition of instability is assumed to be completely established at the start.

(*a*) Imagine a warm layer of air near the ground overlaid with cold air. Such a condition of the atmosphere is unstable, and any disturbance, however minute, may conceivably start a general collapse. Thus a grasshopper in Idaho might conceivably initiate a storm movement which would sweep across the continent and destroy New York City, or a fly in Arizona might initiate a storm movement which would sweep out into the Gulf of Mexico! These results are different, surely, and the grasshopper and the fly may be of entirely unheard-of varieties, more minute and insignificant than anything assignable. Infinitesimal differences in the earlier stages of an impetuous process may, therefore, lead to finite differences in the final trend of the process. And yet it is quite generally believed that if we knew enough we could predict the weather as we predict an eclipse!

(*b*) Consider a smooth spherical ball traveling through still air. There certainly is no more reason to expect the ball to jump to the right than to the left. Therefore we may conclude that it will not jump either way. Similarly, a sharp pointed stick stands in a perfectly vertical position

in a perfectly quiet room, and there is no more reason to expect the stick to fall one way than another, therefore the stick will not fall at all! Every one appreciates the fallacy of this argument as applied to the stick, and the moving ball does in fact jump sidewise.

To understand the behavior of the ball let us think of the ball as standing still and of the air as blowing past in a steady stream. The air streams past the ball and slides over a body of still air behind the ball; the surface which separates the moving air and still air is called a vortex sheet, and a vortex sheet is unstable. Any cause, however minute, is sufficient to start an eddy or whirl, and once started such an eddy or whirl develops more and more. Such an eddy or whirl means that the air streaming past one side of the ball is thrown inwards or outwards, and the reaction on the ball pushes the ball sidewise. This effect can be shown by dropping a marble in a deep jar of water. Instead of moving straight downwards the marble follows an erratic zigzag path. This effect is familiar to every one in the sidewise quivering of a stick in a stream of water; and the hissing of a jet of steam is due to the rapid fluttering of the boundary between steam jet and air because of the formation of innumerable eddies.

METEOROLOGY[6]

There are three fairly distinct objects to be attained in the analysis of weather observations, namely, (*a*) the determination of systematic variations in time and place; (*b*) the elaborate classification of individual storm movements with respect to a great number of measurable characteristics, and the establishment of coefficients of correlation (statistical) between the measurable characteristics of a given type or class of storm on successive days so that weather predictions can be made rationally, that is, definite predictions qualified by probable departures; and (*c*) the recognition of critical states in an individual storm movement (conditions of static or dynamic instability) with the hope of devising means for controlling the storm by the suitable expenditure of a very small amount of energy at the critical time and place. If we are ever to control the weather we must, as it seems, do it in this way, and this would be singing Dan Tucker to a hurricane *not* in accordance with Uncle Remus's idea.

The above-mentioned objects are now kept in view by meteorologists, but the study of classifications and departures should be increased a thousand-fold. The point of view of the meteorologist has in the past been the point of view of the classicist in physics with his preconception of a universe of one-to-one correspondences; but statistical studies are the thing.

STATISTICAL PHYSICS AND THE POSTULATE OF INDETERMINATION

Whenever the postulate of erratic action is set forth, and the probable departure of a natural phenomenon from the most carefully considered prediction is urged as in the nature of things inevitable, we meet objections from two classes of men, namely, the average man who thinks frankly in terms of human values and the classicist in science who idealizes nature in one-to-one correspondences. Surely, the classicist says, "if we knew all" the data we could make an unqualified prediction in any case. But, ignoring the hopelessly unscientific attitude of mind of one who can postulate infinite knowledge, let it be understood that to speak of data in physics is to speak of a very narrow and limited

[6] The proposal here set forth was mentioned in a semi-humorous way in a very short article by W. S. Franklin in SCIENCE, Vol. 14, pages 496–497, September 27, 1901.

kind of thing, for data are only conceivable where measurements can be made or where we have, contrary to Bacon's exhortation, accepted a dream of fancy for a model of the world.

In that branch of mathematical physics which is called statistical mechanics and which includes the atomic theory, we speak of the *complection* of a system when we wish to refer to the positions and velocities of all the elements or particles of the system; let us use this word in the statement of the postulate of indetermination. *The complection of the world to-morrow is not determinate, that is to say, it does not grow out of the complection of the world to-day as a single-valued determinate thing.* This is a postulate which, as it seems, must be accepted as a working hypothesis in the "extra-equilibrium" world, the world of actual happenings, where things never do stand still but go forward by fits and starts impetuously and beyond all control.

LITTLE PHYSICS AND BIG PHYSICS

The most fertile source of ideas in physics is the atomic theory which now runs through the whole of physics. Indeed we now have our atomic theory of elasticity, our atomic theory of crystal structure, our atomic theory of gases, our atomic theory of heat (including the whole of chemistry), our atomic theories in nearly every branch of electricity and magnetism, and our quasi-atomic theories of radiation; and the atomic theory suggests that erratic action is universally dominant in the physics of the very small. Therefore the term micro-physics, or little physics, is frequently used to designate what we have called statistical physics, and the term macro-physics, or big physics, is frequently used to designate the classical physics where nature is idealized more or less and one-to-one correspondences rule.

W. S. Franklin

THE MINING INDUSTRY

The accomplishment of the mining industry in the six-month period just completed warrants the forecast that 1916 is to be a record-breaking year, according to the director of the United States Geological Survey. Active demands and good prices have furnished the mine operators with full opportunity for success in working developed properties, and this in turn has given added incentive and available funds for exploration, prospecting and experimentation with new processes.

Summarizing the special reports which are now being made public, Director Smith continues his review:

The returns for six months furnish a basis for the belief that 1916 will set up a new record for the soft-coal mines. Every coal-mining state is sharing in this prosperity and of course this demand for coal is to be traced back to the increased business of the railroads and of the steel and other large industries.

Drilling activity throughout the oil-producing states has brought about a gratifying increase in production of crude oil that promises to make 1916 a record year for marketed petroleum. Already production and consumption are reported by the surveys specialist as essentially in balance east of the Rocky Mountains, with a tendency to lower prices.

The Portland cement industry has had a busy six months and the manufacturers are optimistic. It is predicted that in both production and shipments of cement this year will show a gain over last year, if indeed it does not establish a new record for cement.

Among the metals copper is continuing the steady increase in production which began early last year, and the forecast for 1916 indicates not only the largest output ever known but also the largest profits.

Shipments of iron ore from Lake Superior points for five months of 1916 exceeded by more than 80 per cent. those for the same months in 1915, and the indications for the year are favorable for a new high record on iron-ore production, and of pig iron as well. Higher prices with a steady demand are stimulating the mining of manganese, with the result that

this year's output of ore is expected to surpass the large production of last year.

The lead and zinc mines are producing ore at a rate even exceeding that of last year and the prevailing prices have made possible the working of large quantities of low-grade ore.

Most precious-metal mines are operating at full capacity. The gold production will probably fall below the high yield of last year, but silver, the one metal last to benefit by the general domestic prosperity, is expected this year to break all previous records.

In quicksilver the outlook is for a continuance of the output of 1915, which was the largest for several years. Thus far in 1916 the average price has greatly exceeded the 1915 prices; and although the reaction in prices has come, conditions are favorable for steady and profitable operation of the quicksilver mines, some of which are newly opened.

The reports from the survey's western offices are all optimistic. In Arizona mines and smelters are working at high pressure, and the production of metals already shows an increase that promises to make the value of the output nearly double that of last year. Arizona will maintain first place as a copper producer. New Mexico is continuing its rapid progress as a metal-mining state, with increases in its output of lead, copper, zinc, gold and silver. The mines of Colorado in the six months just past have shown some changes in output as compared with last year; an increase of 30 per cent. in copper is indicated, together with small gains in lead and zinc, a 15 per cent. decrease in gold, and little change in silver. This output, however, represents a large gain in value of mine production. Mining has also been stimulated in Montana, and the forecast indicates an increase of 60 per cent. in the value of the mine product over that of last year. Here also record outputs may be expected for 1916. Idaho mines are increasing their shipments in all the metals, with higher wages and larger dividends as the result of better prices.

Utah is experiencing an ore production in excess of smelter capacity. The value of the 1916 output of copper is expected to be double that of last year. Throughout Nevada the old term "boom" best expresses the present mining revival. Old mines are being reopened and regular producers are working at full capacity. The chief gains in production will be in copper, lead and zinc. The increased activity in the mining industry of California is finding expression largely in the reopening of mines that have been long idle and the opening of new mines for chrome, tungsten, manganese, antimony and magnesite, rail shipments of these ores to the east being made possible by prevailing high prices. Washington is another state which shows increased production, the mining industry there being in better condition than for several years past. Alaska also is benefiting by the increased activity of its mines. Copper mining is showing great advances, and the output of both copper and gold promises to exceed that of last year.

THE OPTICAL SOCIETY OF AMERICA

AT the recent regular election of the newly organized optical society, the name Optical Society of America was chosen. The officers chosen for the year are: President, P. G. Nutting; Vice-president, G. E. Hale; Treasurer, Adolph Lomb; Secretary, F. E. Ross. The Executive Council consists of the above officers and F. E. Wright, C. E. K. Mees, Norman Macbeth and J. P. C. Southall. The charter members of the society are:

Mr. Adelbert Ames, Jr., research, Clark University; Mr. Edward Bausch, member Bausch & Lomb Optical Co.; Dr. E. J. Bissell, research opthalmologist; Dr. Wm. Churchill, Corning Glass Co.; Professor Louis Derr, professor of physics, M. I. T.; Dr. Marshall D. Ewell, consulting optical engineer; Professor C. W. Frederick, chief, lens designing and testing, E. K. Co.; Dr. H. P. Gage, optical research and design, Corning Glass Co.; Dr. G. E. Hale, director, Solar Observatory, Mt. Wilson; Dr. E. P. Hyde, director, Nela Research Laboratory; Dr. H. E. Ives, optical research, U. G. I. Co.; Mr. L. A. Jones, optical research, E. K. Co.; Dr. H. Kellner, chief, scientific bureau, B. & L. Co.; Mr. C. H. Kerr, director, research laboratory, P. P. Class Co.; Dr. Walter B. Lancaster, research opthalmologist; Mr. Adolph Lomb, member Bausch & Lomb Optical Co.; Mr. Norman Macbeth, editor and

proprietor, *The Lighting Journal;* Dr. C. E. K. Mees, director, research laboratory, E. K. Co.; Professor H. D. Minchin, professor optics, U. of R.; Dr. P. G. Nutting, optical engineer, E. K. Co.; Dr. C. F. Prentice, professor of optometry, Columbia; Mr. I. G. Priest, associate physicist, optics division, Bureau of Standards; Mr. W. B. Rayton, optical design and testing, B. & L. Co.; Professor F. K. Richtmyer, professor of physics, Cornell University; Dr. F. E. Ross, astronomer and optical designer, E. K. Co.; Mr. F. B. Saegmuller, superintendent, precision optics, B. & L. Co.; Professor J. P. C. Southall, professor in charge of optometry courses, Columbia University; Mr. E. D. Tillyer, research laboratory, Am. Optical Co.; Professor E. J. Wall, professor of photography, Syracuse University; Dr. F. E. Wright, optical research, geophysical laboratory (30).

The constitution provides that only those who have contributed materially to the advancement of optics shall be eligible to regular membership in the society and hence to vote or hold office. Any one interested in optics is eligible to associate membership. The affairs of the society are in the hands of the executive council. It is planned to hold one or more annual meetings and publish a journal commencing with the year 1917. Blank application for membership may be obtained from the secretary, 1447 St. Paul St., Rochester, N. Y. Material intended for publication in the journal should be addressed to the president until the editorial staff has been selected by the council.

SCIENTIFIC NOTES AND NEWS

Dr. Haven Emerson, health commissioner of New York, has invited a number of distinguished pathologists to meet some pathologists and medical authorities of New York City for discussion of problems connected with the prevailing epidemic of infantile paralysis. For the conference, which will begin on August 5, the Board of Estimate has appropriated $2,000. Those from a distance who are expected to be present are: Dr. William H. Welch, professor of pathology, The Johns Hopkins University; Dr. Victor C. Vaughan, dean of the medical school of the University of Michigan; Dr. Milton J. Rosenau, professor of preventive medicine and hygiene, Harvard University; Dr. J. W. Jobling, professor of pathology, Vanderbilt University; Dr. Paul A. Lewis, Henry Phipps Institute, and professor of pathology, University of Pennsylvania; Dr. C. C. Bass, professor of pathology, Tulane University; Professor Theobald Smith, Rockefeller Institute; Professor John F. Anderson, New Brunswick, N. J., former head of the hygienic laboratories of the U. S. Public Health Service; Dr. Richard M. Pearce, professor of experimental medicine, University of Pennsylvania; Dr. Francis W. Peabody, Peter Brent Brigham Hospital, Boston; Dr. Ludwig Hektoen, professor of pathology, University of Chicago, and director of the Memorial Institute for Infectious Diseases; and Dr. John G. Adami, professor of pathology, McGill Medical College.

At the meeting of the Royal Society of Edinburgh held on July 3 the following British Honorary Fellows were elected: Sir Francis Darwin, Cambridge; Dr. J. W. L. Glaisher, Trinity College, Cambridge; Professor J. N. Langley, professor of physiology, Cambridge; Professor C. Lapworth, emeritus professor of geology, University of Birmingham; Professor A. Macalister, professor of anatomy, Cambridge; Professor A. Schuster, emeritus professor of physics, University of Manchester.

The Hon. Bertrand Russell, F.R.S., one of the most distinguished English students of philosophy, was, according to a cablegram from London, recently fined for issuing pamphlets to conscientious objectors to military service, and deprived of his lectureship at Trinity College, Cambridge; now it is said he has been refused a passport to visit America to keep his engagement to lecture at Harvard University.

Dr. Franklin C. McLean, assistant resident physician in the hospital of the Rockefeller Institute, New York, has accepted an appointment by the trustees of the Union Medical College, Pekin, to the professorship of internal medicine. The appointment carries with it the headship of the Union Medical School. This is one of the institutions of the China Medical Board of the Rockefeller Foun-

dation. Mr. Charles A. Collidge, of Boston, architect of the Rockefeller Institute and of the Harvard Medical School buildings, has been engaged to draw plans for a 200-bed hospital to be added to the equipment of Union Medical College.

FRED V. LARKIN, assistant professor of mechanical engineering at Lehigh University, who was absent on leave last year, has resigned and will continue in the employ of the Harrisburg Pipe and Pipe Bending Company.

ADVICES from Mr. Roy Chapman Andrews, May 18, indicate that conditions in China will not interfere with the carrying out of the plans of the American Museum's expedition there. Mr. Andrews intends to work in Fukien Province, until the arrival of Mr. Edmund Heller, when the expedition will proceed into Kweichow Province.

DR. HERBERT J. SPINDEN has returned from Venezuela, where he has spent some months in an archeological reconnaissance for the American Museum of Natural History.

G. W. HUNTER, of New York University, has returned from the Tropical Research Station established by the New York Zoological Society in Kalacoon, British Guiana. He brought with him a collection of birds and reptiles.

THE Royal Society of Edinburgh has awarded its Keith prize for the biennial period 1913–15 to Dr. J. H. Ashworth for his papers on "Larvæ of *Lingula* and *Pelagodiscus*" and on "*Sclerocheilus*," published in the *Transactions* of the society, and for other papers on the morphology and histology of *Polychæta*.

PROFESSOR LAFAYETTE B. MENDEL delivered the address before the annual commencement joint meeting of Sigma Xi and Phi Beta Kappa at Yale University.

DR. VICTOR C. VAUGHAN, dean of the medical school of the University of Michigan, delivered an address on "The Eradication of Disease" at the meeting of the health officers of Montana held at Miles City on July 10 and 11.

THE Harben lectures for 1916, on "Rivers as Sources of Water Supply," were delivered by Dr. A. C. Houston at the Royal Institute of Public Health, London, on July 13, 20 and 27.

THE department of geography in the Columbia University summer session has arranged the following course of public illustrated lectures on consecutive Monday evenings:

July 17, "Turkey and the War," by Dr. Ellsworth Huntington.

July 24, "The Philosophy of Present and Prospective Boundaries in Europe," by Professor Albert Perry Brigham, Colgate University.

July 31, "Surface Features of Europe as a Factor in the War," by Professor Douglas W. Johnson, Columbia University.

August 7, "An Interpretation of the Scenery of the White Mountains," by Professor James Walter Goldthwait, Dartmouth College.

THE first annual meeting of the Association of Resident and Ex-resident Physicians of the Mayo Clinic was held in Rochester, Minn., on June 9 and 10. A surgical clinic was given at the hospital, and in the evening papers were read. At the banquet the following officers were elected: *President*, Dr. Harold L. Foss, Danville, Pa.; *Vice-president*, Dr. Donald C. Balfour, Rochester, Minn.; *Secretary*, Dr. William C. Carroll, St. Paul; *Treasurer*, Dr. Arthur H. Sanford, Rochester, Minn., and *Governors*, Drs. Edward S. Judd and William F. Braasch, Rochester, Minn., and Otis F. Lamson, Seattle.

DR. PAUL J. HANZLIK, associate in pharmacology, Western Reserve University, gave a lecture on July 6, in the Graduate School in Medical Sciences, University of Illinois, Chicago, on "The Behavior of Salicylate in the Body."

PROFESSOR WILLIAM COLE ESTY, professor emeritus of Amherst College, from 1865 to 1905 Walker professor of mathematics and astronomy, died on July 27, at the age of seventy-eight years.

DR. WILLIAM SIMON, professor of chemistry at the College of Physicians and Surgeons, Baltimore, known for his work on chromates, died on July 19, aged seventy-two years.

CHARLES RUDOLPH EDWARD KOCH, secretary of the Northwestern University Dental School, past adjutant general of the Grand Army of the Republic, died on July 20, at the age of

seventy-two years. Colonel Koch, who was one of the best known dentists in the United States, spent many years of his life in working for the interests of the Grand Army of the Republic as well as for the interests of the dental profession.

The Memorial Hospital, a part of The Medical College of Virginia Corporation, has recently received $250,000 from the citizens of Richmond and a few outside friends. These funds will be used for the addition of a new ward for Negroes, a contagious ward and a nurses' home.

The Civil Service Commission has announced that the applications received for the examination for scientific assistant in oceanography, male, previously announced to be held on July 5, 1916, were insufficient; the examination has been postponed, and will be held on August 23. From the register of eligibles resulting from this examination certification will be made to fill a vacancy in this position at $900 a year in the Bureau of Fisheries, Department of Commerce, Washington, D. C., and vacancies as they may occur in positions requiring similar qualifications. Additional information may be obtained on application to the Civil Service Commission, Washington, D. C.

The new wharf and library-museum building of the Scripps Institution for Biological Research of the University of California at La Jolla will be dedicated on August 9.

Professor C. W. Howard, of the state farm, is in charge of sixteen University of Minnesota students who, under his direction, are endeavoring to exterminate mosquitoes in a section of Minneapolis covering 8 square miles. The work includes the covering, screening and destroying of tin cans, rain barrels and other water containers and the oiling of stagnant pools and swamps.

The Harvard Medical School has established four fellowships in medicine, to be known as the Boston Dispensary Fellowships. Applicants must have graduated from a medical school of good standing and must have had a hospital internship or its equivalent. Appointments will be made jointly by the authorities of the Harvard Medical School and of the Boston Dispensary. The fellows will be expected to give a portion of their time to treating the sick in their homes in the district service of the dispensary, and a portion of their time to such study, teaching, laboratory, research or clinical work as may be assigned by the medical school. The stipend of a fellowship will be $500 for part time, or $750 for the physician's entire time.

Arrangements for the course of lectures on illuminating engineering to be given at the University of Pennsylvania in September are rapidly being completed. These lectures will be open to all engineers, surgeons, manufacturers, and others interested in illuminating engineering, and the course is designed to indicate the proper coordination of those arts and sciences which constitute illuminating engineering and to furnish a condensed outline of study suitable for elaborating into an undergraduate course, and to give engineers an opportunity to obtain a conception of the science of illuminating engineering as a whole.

At a recent meeting held in the rooms of the Chemical Society, London, the Association of British Chemical Manufacturers, which has been under consideration for some time, was definitely formed. Among its main objects are to promote cooperation between British chemical manufacturers, to act as a medium for placing before the government and government officials the views of such manufacturers upon matters affecting the chemical industry; to develop technical organization and promote industrial research; to keep in touch with the progress of chemical knowledge and to facilitate the development of new British industries and the extension of existing ones, and to encourage the sympathetic association of British chemical manufacturers with the various universities and technical colleges. The membership is confined to British firms engaged in chemical manufacture or closely allied industries. The minimum annual subscription is 25 guineas in respect of a subscribed capital of £50,000 or less, rising by 2½ guineas for

each additional £10,000 up to a maximum of 250 guineas. A provisional committee has been appointed, to hold office for three months and including: Dr. E. F. Armstrong (Messrs. Joseph Crosfield and Sons), Mr. F. W. Brock (Messrs. Brunner, Mond and Co.), Dr. Chas. Carpenter (South Metropolitan Gas Co.), Dr. M. O. Forster (British Dyes, Limited), Mr. John Gray (Messrs. Lever Brothers), Mr. Norman Hoden (Messrs. Hardman and Holden), Mr. C. A. Hill (British Drug Houses, Limited), Mr. C. P. Merriam (British Xylonite Company), Sir Alfred Mond, M.P. (Mond Nickel Company), Mr. Max Muspratt (United Alkali Company), Sir William Pearce, M.P. (Messrs. Spencer, Chapman and Messel), Mr. R. G. Perry (Messrs. Chance and Hunt), Mr. R. D. Pullar (Pullar's Dye Works), Dr. Alfred Ree (Society of Dyers and Colorists), Mr. A. T. Smith (Castner-Kellner Alkali Company), and Mr. John W. Wilson, M.P. (Messrs. Albright and Wilson).

IN an item published in SCIENCE for July 7, the cost of printing for the Cornell and Geneva Agricultural Experiment Stations was reported as $60,000 each, whereas this was probably the sum for the two institutions. We are informed that at the Geneva Station the cost of bulletins and reports for three years has been as follows: 1913, $11,978.85; 1914, $14,514.28; 1915, $14,944.81. These figures include the cost of both bulletins and the annual reports, with the exception of Part 2 of 1915, known as "The Cherries of New York." This cost $4,455 extra.

ACTION by congress has recently created six new scientific positions in the division of scientific inquiry of the Bureau of Fisheries. The positions comprise two assistants for the Washington office, two field assistants and a superintendent and scientific aid for the laboratory to be constructed at Key West, Florida. The bureau will be enabled to extend its scientific work particularly in relation to marine shellfish, fresh-water mussels and fishery problems of the Gulf of Mexico. A slight increase was made in the appropriations for miscellaneous expenses available for investigations. The Bureau of Fisheries has never before received in one year so substantial an increment to its scientific staff.

THE secretary of commerce announces the completion of the work at the Rio Grande to the westward of Brownsville, Texas, and Matamoras, Mexico, which connects the triangulation systems of the United States and of Mexico. In the United States the arc of primary triangulation extends from the northwestern part of Minnesota southward along the ninety-eighth meridian to the Rio Grande, and Mexico had extended an arc of primary triangulation along the ninety-eighth meridian from its Pacific coast to the Rio Grande. Mr. E. H. Pagenhart, of the Coast and Geodetic Survey, and Mr. Silverio Aleman, of the Mexican Geodetic Commission, in April and May, made the observations from towers erected on both sides of the river and the work was successfully completed. The length of the completed arc is 2,270 miles. This is a notable event in the history of geodesy and will make it possible to have the maps of the two countries harmonize at the border.

UNIVERSITY AND EDUCATIONAL NEWS

LAST December, the University of Illinois purchased for its School of Pharmacy, property at the corner of Wood and Flournoy Streets, with two substantial brick buildings. One of these is a four-story college building containing a large auditorium, several lecture and recitation rooms as well as offices, microscopical laboratory and several smaller laboratories. This building was formerly occupied by a medical college. The second building was constructed for a hospital and is now being remodeled as a laboratory building in which will be located the qualitative analytical laboratory, the laboratory for organic chemistry and the pharmaceutical laboratory. The college building was occupied by the school on June 1. The trustees of the university have appropriated $32,000 for refitting the buildings, providing new heating, lighting and plumbing, as well as new furniture and equipment for lecture halls and laboratories.

Dr. J. W. Shipley, who during the last two years has been assistant professor of analytical chemistry at the Ohio State University, is going to the Agricultural College of the University of Manitoba, Winnipeg, as assistant professor of chemistry.

Mr. F. S. Nowlan, of Columbia University, has been appointed instructor in mathematics at the Carnegie School of Technology, Pittsburgh, Pa.

At Lehigh University, R. L. Spencer has been promoted to be assistant professor of mechanical engineering and S. J. Thomas to be assistant professor of biology.

DISCUSSION AND CORRESPONDENCE

ATMOSPHERIC TRANSMISSION

To the Editor of Science: Replying to the first point in Mr. Abbot's communication in Science for February 18, 1916, page 240, in reference to the variability of atmospheric transmission of solar radiation during a single day, I have never denied that occasions may be found when the diurnal transmission is substantially constant, but have distinctly averred that such uniformity sometimes exists. What I must deny, however, is that the Mount Wilson observations of September 20 and September 21, 1914, are in the category of measurements unaffected by diurnal changes of transmissivity. The trifling variations from minute to minute on these dates may indeed have been small, but these are not now in question. They may be eliminated for our purpose by passing a mean curve through the plotted observations; but when thus smoothed, the mean curve shows peculiarities which can not be neglected. I have drawn such curves and find the following significant features:

Concerning ourselves simply with the transmission of solar radiation by a unit of atmospheric mass, equivalent to a single vertical transmission, if the rays presented for transmission were of unvarying quality, and if the transmissive properties of the atmosphere remained likewise unchanged through the day, we should have a perfect day for the purpose of the deduction of the solar constant from a comparison of high-sun with low-sun measures. But, in general, neither of these desiderata exist. For example, on September 20, 1914, between air masses 2 and 3, the radiation fell off from 1.437 to 1.311. Transmission by unit mass,

$$T_{(2-3)} = 1.311/1.437 = 0.9124.$$

Between air masses 7 and 8, the radiation diminished from 0.983 to 0.922.

$$T_{(7-8)} = 0.9378.$$

Here it is as if the air had become more transmissive, although this undoubtedly means that, for one thing, the rays which have penetrated more deeply have become more transmissible through the total loss of some of their more absorbable ingredients. Be this as it may, we can not discriminate between this source of variability and another one which is always present (and always potent except in times of extreme cold) and which comes from the evaporation of water at the earth's surface and the ascent of considerable masses of aqueous vapor into the convectional layer of air *in the middle of the day,* whereby the midday atmosphere becomes less transmissive, and the apparent transmission deduced from comparison of high-sun with low observations is illusory.

For air masses 14 and 15, the radiation was 0.680 and 0.648; $T_{(14-15)} = 0.9530$. That is, there was still a further increase of transmissivity of unit air mass with this larger departure from midday conditions. Similar results are found on September 21, 1914, namely,

$$T_{(2-3)} = 1.297/1.437 = 0.9028,$$
$$T_{(7-8)} = 0.889/0.947 = 0.9390,$$
$$T_{(14-15)} = 0.630/0.660 = 0.9545.$$

M. R. Savélief, observing in Russia in very cold weather, obtained between air masses 4.5 and 5.5 a transmission equivalent to that for Mount Wilson between air masses 2 and 3, and was able to match Mount Wilson $T_{(7-8)}$ with the interval between air masses 9 and 10. His observations represent a much closer approach to uniform transmission than those cited by Mr. Abbot; and this is doubtless due to the comparative absence of aqueous vapor whose pressure at the earth's surface was from 0.7 to 0.9 mm. in the Russian measures, whereas the Mount Wilson observations were made with

pressures of water vapor varying between 4.62 and 9.99 mm. on September 20, and between 2.21 and 7.49 mm. on September 21. The total quantity of precipitable water in the atmosphere on September 20, as determined by Fowle's spectroscopic method, varied between 3.32 at low-sun observations to 8.6 mm. at high-sun observations, and on September 21 between 3.8 and 8.3 mm. Thus there was between two and three times as much water vapor present in the midday air as there was at low-sun observations. Since the transmissivity of the atmosphere is known to diminish with the increase of aqueous vapor, other things remaining equal, would it be at all likely that Mr. Abbot's assertion that the transmissive quality of the atmosphere above Mount Wilson remained unchanged throughout these days, should turn out to be true? And do not the partial transmissions which I have derived from his own figures point to a contrary conclusion?

In his second paragraph, Mr. Abbot tries to discredit my measurements of the distribution of intensity in the spectrum of the earth-shine, because my statement that the night sky at Flagstaff in the early morning of August 9 and 10, 1912 (civil reckoning), was exceptionally clear, appears to him incompatible with the experience of himself and others that the "skylight near the sun in daytime notably increased" during that month. My statement rests upon the following evidence:

The spectrograms of the earth-shine were made for me at Dr. Lowell's observatory by Dr. V. M. Slipher. I had asked Dr. Slipher to place the slit of his spectroscope half on and half off the dark limb of the moon. In this way there were obtained juxtaposed spectrograms of precisely the same duration of exposure and photographic development, one of the earth-shine *plus* diffuse skylight from intervening air, illuminated by the light passing through it from the bright crescent of the moon, and the other of the skylight alone, from which the true earth-shine was obtained by difference. Dr. Slipher had given me his impression from eye estimate that the sky on August 8 (astronomical date) was "good," and on August 9 "excellent"; but my quantitative measurements are far superior to any eye estimates, and these tell the following story:

Without going into the minutiæ of the photographic corrections, I will merely record that all necessary corrections of this sort have been applied. Those interested will find the details given in my paper on "The Photographic Spectrography of the Earth-shine and a Spectrophotometric Comparison of the Earth-shine with Moonlight, Skylight and Sunlight, together with a Study of the Difficulties of Photographic Comparisons."[1]

The ratios of exposure durations for earth-shine (t_E) and for moonlight (t_M) were

August 8, 1912, $t_E : t_M = 4800 : 1$,
August 9, 1912, $t_E : t_M = 2840 : 1$.

The average of the ratios of photographic opacities on the spectrograms for earth-shine and moon (J_E/J_M) and for earth-shine and sky (J_E/J_S) were

August 8, 1912, $J_E/J_M = 1.360 : 1$; $J_E/J_S = 3.62 : 1$,
August 9, 1912, $J_E/J_M = 1.062 : 1$; $J_E/J_S = 8.49 : 1$.

The ratios of moonlight to the skylight just outside of the extreme border of the moon's dark limb were therefore

$$\text{August 8, 1912, } \frac{t_E}{t_M} \times \frac{J_M}{J_E} \times \frac{J_E}{J_S} = \frac{4800 \times 3.62}{1.360} = 12{,}776 : 1,$$

$$\text{August 9, 1912, } \frac{t_E}{t_M} \times \frac{J_M}{J_E} \times \frac{J_E}{J_S} = \frac{2840 \times 8.49}{1.062} = 22{,}704 : 1.$$

For comparison I give corresponding values of the ratio of moonlight to skylight, obtained at Westwood, Massachusetts, during my visual measures of the earth-shine, which give an idea of the variation which is to be anticipated in skies ordinarily reputed "clear": 1911. Sept. 28, 52:1 (sky hazy); Sept. 30, 3095:1 (clear); Oct. 2, 1149:1 (clear, followed by cirro-stratus); Oct. 26, 3033:1 (clear); Oct. 29, 3626:1 (clear); Nov. 16 (A.M.), 1871:1 (clear); Nov. 17 (A.M.), 8579:1 (exceptionally clear); Nov. 27, 1358:1 (clear to hazy); Dec. 14 (A.M.), 9380:1 (exceptionally clear). 1912. Feb. 20, 2476:1 (faint cirrus bars).

Here the greatest degree of clearness at this station about 200 feet above sea level, gave a

[1] *Astronomische Nachrichten*, Nr. 4819–20, November, 1915.

ratio of not over 10,000 : 1, which falls considerably short of the Flagstaff conditions on either of the given dates.

It seems to me that I am fully justified in calling the mornings of August 9 and 10, 1912 (civil date), exceptionally clear, even for Flagstaff; and I submit that exact quantitative measurements, such as I have given, are to be preferred to Mr. Abbot's vague estimate that "skylight near the sun in daytime notably increased." If the discrepancy is regarded as sufficiently noteworthy, I would suggest that it indicates that the "dust cloud from Katmai" was not as universal as Mr. Abbot supposes. Mr. Abbot has inferred from the consistent agreement of his observations with those of some other observers, that the obscuration which he attributes to the eruption of Katmai was world-wide and continuous; but this is a mere hypothetical conjecture, in the absence of anything known to the contrary, which a single good opposing observation can overthrow.

While the presence of a clear and uniform sky is an advantage in such delicate measures as those of the spectrum of the earth-shine, it is not an indispensable one, because my method of observation permits accurate measurement of and correction for the interfering skylight; and it is not quite exact to say that "Mr. Very hangs the merit of his work on the exceptional clearness of August 8 and 9, 1912," because I have given these observations no greater weight in the final result than is assigned to other dates when the skylight was considerably stronger than the earth-shine. Being freed from the variable effect of skylight, my measures are sufficiently exact to show not only the variation of the earth-shine from day to day with the changing phase of the illuminating earth, but they also detect variations in the quality of the light which are attributable to a variable proportion of blue "skylight," *i. e.*, sunlight scattered upward by the clear air in the same way that skylight is scattered downwards, and varying in amount according to the cloudiness of the earth's hemisphere facing the moon.

Coming to Mr. Abbot's third point, in which he defends the conclusions of Mr. A. Ångström, who finds a mean atmospheric transmission of terrestrial radiation by clear air of about 15 per cent., where I obtain about 40 per cent., I anticipated Mr. Ångström's curve of instrumental radiation to limited areas of sky at different zenith distances, and obtained a similar, but more accurate curve;[2] but I did not make his mistake of confounding this purely instrumental result with the radiation of the earth's surface to outer space. It is true that the radiation from a small surface so circumscribed that the rays can only escape through a narrow aperture, pointing to the sky in a direction but little elevated above the horizon, so that the path through the lower moisture-bearing layers of the atmosphere is equivalent to a passage through a considerable depth of water, is usually so impeded that scarcely any gets through. But the radiation of the indefinitely extended surface of the earth, free to radiate vertically through a comparatively shallow layer of moist air, escapes readily. For such radiation there is an extensive region of the spectrum between 8.5 and 12.8 μ, where the transmission averages something like 80 per cent. Yet even the maxima, or spectral regions of comparatively free transmission, are almost obliterated in the long road through the air in a pointing not much above the horizon. This is an important fact, and its explanation has seemed to me to lie in the presence of multitudes of excessively faint absorption lines in the parts of the spectrum where the maxima reside—lines which are too fine and too faint to be individually discriminated by the bolometer, but which increase in intensity and finally produce a somewhat general obscuration of the spectrum, even in its more transmissible portions, when the air path becomes excessive. The recognition of the existence of these faint lines by Mr. Abbot would go a long way towards removing the discrepancy between our points of view.

I will not trespass on your space to point out the numerous errors in Mr. Ångström's

[2] See my paper, "Sky Radiation and the Isothermal Layer," *Am. Jour. Sci.*, Vol. XXXV., Fig. 2, p. 383, April, 1913.

argument, since my paper on "Fundamental Distinctions Special to the Process of Transmission of Terrestrial Radiation by the Atmosphere, and the Value which is obtained for the Coefficient of Transmission when these are considered" will appear in full in the *American Journal of Science*. [The paper has since been published in the issue for June, 1916, Vol. XLI., pp. 513–521.] FRANK W. VERY

WESTWOOD ASTROPHYSICAL OBSERVATORY,
February 22, 1916

SOME NOTES ON THE OLYMPIC PENINSULA, WASHINGTON. A REPLY TO CRITICISMS BY ARNOLD AND HANNIBAL

IN "The Marine Tertiary Stratigraphy of the North Pacific Coast" by Ralph Arnold and Harold Hannibal, page 604,[1] is this paragraph:

> A. B. Reagan, 1908, "Some Notes on the Olympic Peninsula." Most of the geological data in this paper are adopted from one by the senior writer (Arnold) mentioned. . . . The description of the Quillayute formation is based on the glacial filling of the valley of the Quillayute River. If Reagan had visited the locality from which the fossils described from the Quillayute (formation) were brought by Indians, he would have found it to be about two miles from Devil's Club Swamp where he says they occur, and the formation lithologically very different from what he describes. It is typical Empire formation.

Mr. Arnold's article that he says my work was adopted from is "Geological Reconnaissance of the Coast of the Olympic Peninsula, Washington,"[2] totalling 18 pages; my cited article, "Some Notes on the Olympic Peninsula," covers 108 pages besides plates.

I visited the region and collected the fossils described myself, with the exception of the fossil *Ranella marshalli*, which was given me by Mr. Marshall, as is stated in the article. I made a good many trips to the place both with Indians and whites. We went both by canoe up the river and also on foot in from Quillayute Prairie. James Clark, now county commissioner of Clallam County, Washington, accompanied me on my first trip; George Woodrough, now of Ilwaco, Washington, was with me on another trip. On practically all the trips I crossed the Devil's Club Swamp from the bend in the river to the bluffs adjacent and north of where Maxfield Creek entered Quillayute River when that river ran against the western bluffs, instead of about a half mile eastward as it does now (at the old mouth of Maxfield Creek—not a later mouth of that creek). No fossils were collected in the Devil's Club Swamp; the article is very plain on this point, that the fossils were collected in the bluffs west of the old mouth of Maxfield Creek (that is, from near the present mouth northward along the bluffs).

I will now quote from page 203 of my cited article:

> *Quillayute Formation.*—(This is under the general heading "Pliocene," on page 202.) This formation occupies the valley of the Quillayute River and the country drained by its western tributaries at least to their respective middle courses. . . . The boundaries of the formation were not determined. In the interior region, where exposed along the Bogachiel River, it is composed of *sandstone and bluish shale;* the coast exposures are all conglomerates or a coarse, gravelly rock resting unconformably upon the older rocks exposed there. The base of the formation was not seen, consequently was not ascertained. The sandstone series was found to be extremely fossiliferous, and in it the fossils are beautifully preserved. Fossils were found in two horizons—in the north bank of the Bogachiel River in a bluish gray rock in section 22, township 28 north, range 14 west of the Willamette meridian, and in the *bluff south of the abandoned channel of Maxfield Creek on the south side of the Bogachiel River*, in sections 28 and 29 of the township and range above. But fossils were obtained only from the latter location, as the former was below the surface of the water at the time visited. Below is a description of the fossils obtained.
>
> *Fossils of the Quillayute Formation—Lower? Pliocene, exposed in the Vicinity of Quillayute, Washington:*

Here follows a two-page comparison of the Quillayute-formation fossils with the fossils of other regions, with the final conclusion (page 206) that:

> Consequently, this (the comparison results) would seem to place the formation at the bottom

[1] Reprint from *Proceedings of the American Philosophical Society*, Volume LII., No. 212, November-December, 1913.

[2] *Bull. Geol. Soc. America*, Vol. 17, pp. 451–462.

of the Pliocene. Following is a description of the fossils:

Here follow twenty-two pages, pages from 205 to 226, describing the fossils of the Quillayute formation. I will add that I described no fossils whatever from the glacial deposits, or Quaternary deposits of the Olympic Peninsula. Furthermore in describing each fossil I gave a notation after it telling where it had been found; for example, take *Yoldia cooperi*, fossil number 34, described on page 206 of the article. The notation following the description is as follows:

Living: Half Moon Bay, California (Arnold); San Diego to Santa Cruz (Cooper).
Pleistocene: Ventura, San Diego, Cal. (Arnold); San Pedro (Arnold; Cooper).
Pliocene: San Fernando (Cooper); Portata Valley, California (Arnold).
?Pliocene: Mouth of Quinaielt River, Granville, Wash. (Arnold), Quillayute, Wash. (Reagan).

Again take number 35, *Cardium meekianum* Gabb, on the same page. The notation is:

This is quite a numerous species of the Pliocene at Quillayute, Wash.
Pliocene: Humboldt county, California (Gabb); Quillayute, Wash. (Reagan).

In correlation, the sandstone and bluish shale of the Quillayute formation, which I definitely described in my article as composing the formation, is typical Empire sandstone and shale.

ALBERT B. REAGAN
PRINCIPAL, U. S. INDIAN SCHOOL,
IGNACIO, COLORADO

NOMENCLATORIAL FACTS

Two cases have been recently cited in the present journal by Mr. A. N. Caudell as showing nomenclatorial inconsistency in the attitude of the present writer. That this is true, or that, as Mr. Caudell infers, unanimity among systematists is hopeless, we are entirely unprepared to admit.

In the first case we have claimed that *Pedeticum* of McNeill is preoccupied by *Pedeticus* of Laporte.[1] As the International Code has as yet *not* acted on this matter, we are led to this decision by Canon 20, page lviii, 1898, of the A. O. U. Code. Mr. Caudell refers to Article 36 of the International Code, but indirectly quotes only a recommendation there found. Such recommendations have been admitted, by the secretary of the International Commission, to have no force of law. Furthermore, Opinion 25 of the International Commission, also cited by Mr. Caudell, does not bear on the subject, as in the present case the matter involved is simply a case of different gender termination, while in the case of *Damesella* and *Damesiella* the Commission, in Opinion 25, is obliged to fall back on Section K of Recommendation of Article 8, "a name composed of arbitrary combinations of letters." The results obtained were the International Code to disagree with the A. O. U. Code would create such difficulties that we feel confident that the International Code will be found to agree with that of the A. O. U., when this matter is finally acted upon. As an instance, in the case of *Aplodontia*, twenty-four emendations have already been found and cited by Palmer,[2] the confusion possible, were each of these eligible for distinct generic rank, is evident.

In regard to *Libell[ula] americanus*, Drury nowhere in his work suggests a different generic position for this name. The use of *Libellula* may constitute a lapsus calami, but it would seem an assumption that *Gryllus* is the intended genus, where *Locusta* or *Acrydium* might have been intended. We regret that we feel obliged to criticize the quoted opinion of Dr. Stiles and concurrence in the same of Dr. Stejneger. Drury's index, in which *Libell[ula] americanus* is found is *not* known to be of a later date than his first volume; it is Westwood, in his edition of Drury, who first suggests *Gryllus* to replace *Libellula* for this species, and the "obvious" lapsus calami is not as obvious or as easily disposed of when the original edition of Drury is considered. It appears probable that Dr. Stiles's unofficial opinion is based rather upon second-hand information than upon examination of the original edition of Drury.

We are strongly in favor of both of these cases being brought before the Commission

[1] *Ent. News*, XXVII., p. 17 (1916).

[2] "N. A. Fauna," XXIII., p. 25 (1904).

for a final decision; the former for a much-needed rule as to whether or not "a generic name is to be considered identical whether the ending is masculine, feminine or neuter" if from the same root; the latter for an official opinion as to whether a lapsus calami does or does not exist in the case of *Libell[ula] americanus* Drury.

In the meantime we feel that our action is as clear and consistent as is possible, our aim being to follow the official decisions of the International Code, and, in cases where action has not as yet been taken, to follow that course which, after careful consideration, we believe most likely to coincide with the later rulings of that body.

We naturally do not relish our work being used as a striking illustration of the hopelessness of unanimity among systematists on nomenclatorial matters, but we could hardly hope for a less gloomy viewpoint from one of the authors of "The Entomological Code" the first rule of which recommends in the vernacular "everybody for himself."

MORGAN HEBARD

CHESTNUT HILL, PA.

SYLVESTER AND CAYLEY

ON page 781 of the last volume of SCIENCE there appeared a criticism relating to a statement in my recent book entitled "Historical Introduction to Mathematical Literature." The statement in question seems to be the following: "Cayley and Sylvester were students at Cambridge at the same time and formed then a lifelong friendship," which appears on page 259. In view of the fact that a "colossal error" is said to have been committed it may be of interest to compare the given sentence with the following quotation from the third edition, page 484, of "A Short Account of the History of Mathematics," by W. W. R. Ball:

> He (Sylvester) too was educated at Cambridge, and while there formed a life-long friendship with Cayley.

The same statement appears in the fifth edition (1912) of Ball's "History" and an equivalent form of it is found in the reviewed and augmented French translation of the third edition.

The fact that Ball has been connected with Trinity College, Cambridge, for a long time and that he was Fellow of this college during many years while Cayley was professor in the University of Cambridge led me to place more confidence in the given statement as a reliable historical fact than I should otherwise have done. While I do not now recall all the evidence at hand when writing the sentence which has been the subject of said criticism, it appears to me that the given evidence is sufficient to warrant this sentence until it can be proved that this evidence is unreliable.

G. A. MILLER

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SCIENTIFIC BOOKS

Fundamental Conceptions of Modern Mathematics, Variables and Quantities, with a Discussion of the General Conception of Functional Relation. By ROBERT P. RICHARDSON and EDWARD H. LANDIS. Chicago and London, The Open Court Publishing Company, 1916. Pp. xxi + 216.

According to the announcement near the end of the present volume "that portion of 'Fundamental Conceptions of Modern Mathematics' dealing with algebraic mathematics will consist of thirteen parts." The volume under review is Part I. and has as subtitle "Variables and Quantities with a Discussion of the General Conception of Functional Relation." The magnitude of this undertaking and the fundamental character of the questions considered combine to direct unusual attention to the project, and hence the present volume is of interest not only on its own account, but also on account of the hopes or fears it may inspire as regards the remaining volumes of the projected series.

A striking feature of this volume, which will doubtless create at the start an unfavorable impression on many mathematical readers, is the somewhat harsh criticism of some of the work of many eminent mathematicians, including Baire, Bauer, Pringsheim, Riemann, Russell, Weber, and many others. For in-

stance, on page 152, we find the following statement: "Among English mathematicians of the Peano School the Honorable Bertrand Russell stands preeminent. He is the author of a ponderous and pretentious treatise entitled 'Principles of Mathematics.'" On page 192, we find the following sentence: "The blunder of thinking that in a functional relation between two variables the one variable *necessarily* alters its value when the value of the other alters is, we hope, so far obsolescent as to be peculiar at the present day to the learned ordentliche Professor of the University of Munich."

On page 145, we find the following severe stricture on authors of English text-books: "Practically all the mathematical text-books now in use in England and the United States, either give no definition at all of variable and constant, or reproduce almost verbatim the definition of Newton. As, however, such text-books are brought forth almost invariably by mere compilers, rather than mathematicians of authority, we turn to continental Europe, where we find equally bad definitions from more authoritative sources." On page 195 appears the statement that "inability to use language with precision seems to be a failing endemic among mathematicians, and Riemann was not immune"; and on page 151 the reader is enlightened by the comprehensive remark that a mathematician "can seldom lay claim to more than a narrow technical education."

The fact that authors of a mathematical work criticize rather harshly a considerable number of eminent mathematicians and direct attention to common failings of the tribe is in itself no conclusive evidence against these authors, but it naturally leads the mathematical reader to assume a somewhat critical attitude with respect to such authors; especially when, as in the present case, most of the authors' criticisms relate to definitions or to the choice of words. The critical reader of the present volume will not need to look long to find evidences tending to show that its authors were not, at the time of writing, familiar with some very well known mathematical facts.

For instance, on page 35, we find the following statement: "The only mathematician that we recall as making a specific distinction between quotient and ratio is Hamilton." As a matter of fact this distinction is so common that in the "Encyclopédie des Sciences Mathématiques," tome I., volume I., page 44, it is proposed to restrict the use of the symbol: as an operational symbol to represent a ratio, instead of continuing its use to represent both a ratio and also the operation of division.[1] On page 177, and elsewhere, the common erroneous assumption according to which the word function was used by the older analysts as synonymous with power is repeated notwithstanding the fact that about seven years ago there appeared in the "Encyclopédie des Sciences Mathématiques," tome II., volume 1, page 3, a clear exposition of the way in which this error crept into the literature.

The main question involved in a review of the first volume of an extensive projected series relating to fundamental questions in mathematics is, however, not much affected by occasional historical inaccuracies or by infelicitous statements relating to eminent mathematicians and to mathematicians as a class, even if these facts are not void of important implications. To the reviewer the present volume appears to be poorly adapted for the mathematical reader, since the treatment is often prolix and involves many considerations of little mathematical import. According to the preface, the key-note of the work "is the distinction we find it necessary to make between quantities, values and variables on the one hand, and between symbols and the quantities or variables they denote or values they represent, on the other."

Probably most mathematicians will be more interested in the definitions given by those who have made important advances in the fields to which these definitions are related than in those given by men who appear to be mainly interested in philosophical speculations. This is especially true in case the latter authors exhibit evidences of knowing

[1] *Cf.* G. A. Miller, *School Science and Mathematics*, Vol. 7 (1907), p. 407.

little about the mathematical literature. For instance, we find on page 33 of the present volume the statement that mathematical works afford no reply to the question which of the ordinary complex numbers should be regarded as positive and which as negative. The fact is that the terms positive and negative are commonly applied only to real numbers and the reviewer does not see an advantage resulting from the use of these terms in connection with complex numbers as proposed by the authors of this volume. For a very elementary generalization of the terms positive and negative numbers we may refer to volume 15 (1908) of the *American Mathematical Monthly*, page 115.

As regards form the volume under review could have been made more useful by the addition of headings of sections. If the series is continued it is to be hoped that the future volumes will be improved along this line as well as along the line of more complete references and less prolixity in the development of the special views of the authors. While the many shortcomings of the present volume have forced the reviewer to the conclusion that the series will be used by only a small number of mathematicians unless the future volumes should exhibit a marked improvement over the one before us, he recognizes the need of a scholarly work on the general subjects selected by the authors of this volume, and he would like to hope that the later volumes of the series may tend to fill this want.

G. A. Miller

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Harvey's Views on the Use of the Circulation of the Blood. By John G. Curtis. Columbia University Press, New York, 1915. 8vo. Pp. 194, 4 pls.

It is a great source of inspiration to feel that one belongs to a goodly company possessing a common ideal and a common interest. What enthusiasm is aroused in us by a great International Congress of scientists! Here the appeal is made to our social sense, but there is a second powerful appeal, that to our historic sense. This comes when we realize that we of to-day are but the visible part of a long line of precursors who have been our teachers and the teachers of our teachers and have handed down through the ages the enthusiasm for knowledge and truth which we consider our dearest heritage. Just as none of us can afford to be provincial, so none of us can afford to neglect the history of scientific thought. That would be to affirm the importance of evolution in theory while denying it in practise.

At this time when proper international relations are interrupted it is a solace to turn from the present to the past and to strengthen our acquaintance with the illustrious scientists of former times. This is especially desirable when we can do so in the company of one whose familiarity with ancient viewpoints makes him a competent expounder of that which time has rendered obscure.

The theme of Professor Curtis's book is clearly stated in the title. To make Harvey's views intelligible to us we are introduced to the illustrious ancients from whom, next to nature, Harvey drew most of his learning or who colored learned opinion in Harvey's time. Harvey's importance as a discoverer has long been recognized, but for a lucid explanation of his place in the history of scientific thought we have waited for this book. Our sincere thanks are due to Professor Lee, who has completed and published the manuscript left by Professor Curtis.

Nutrition.—According to Aristotle and Galen (who borrowed the idea from Plato) the parts feed themselves tranquilly from the blood vessels, which act as irrigating ditches in the garden. So why, asks Harvey, this rush of such great quantities of blood through all parts of the body? Although Harvey recognized that such a mechanism as the circulation was most useful in explaining intestinal absorption in that it did away with the classic belief that in the portal vessels there were two currents, one carrying blood to the intestines and the other carrying absorbed food to the liver, still he could not believe that the sole use of the circulation was the feeding of the parts.

Respiration.—In his quest of the meaning

of the circulation Harvey naturally reviewed what little was known of the respiration in regard to which there were current at this time two ancient beliefs, (1) the refrigerating action and (2) the production of vital spirits. The Hippocratic writers believed that in spite of the obstruction of the semilunar valves some air entered the heart to cool it. Aristotle amplified this view, stating that the action of the air upon the innate heat which had as its origin and seat the heart, was like the action of the air in respect to a fire—it cooled it and prevented too rapid combustion. The second conception was also as old as Hippocrates. It consisted in the belief that something derived from the inspired air (spirits) enters into the heart and thence passes by the vessels to all parts of the body. Aristotle rejected this doctrine and taught that the spirits are not derived from without. When the arteries and veins came to be distinguished and the former were found empty, it was thought that during life the spirits filled the arteries while the blood filled the veins, and when Galen proved that the arteries also contained blood it was at once concluded that this blood, unlike that in the veins, was spirituous.

For a while Harvey held both of these views. Then first he disposed of the notion that the blood received anything from the lungs by observing that the pulmonary veins contain blood only and not blood and air. This conclusion was not justified, since from the same premises Columbus inferred that the concoction of the air and blood to make the spirituous blood takes place in the lungs and that in the pulmonary veins the two are no longer separable. For a longer time Harvey adhered to the refrigerating action of the respiration, but in his old age he was inclined to doubt its importance, for the fetus required no refrigeration of its innate heat. So it was of no use to turn to the respiration for any light as to the uses of the circulation.

Primacy of the Heart.—But might it not be that the body needed heat and spirits from the heart which is, according to Aristotle, the center of heat and of the soul? Aristotle's doctrine of the primacy of heat had been denied by Galen who pointed to the tricuspid valve (of which Aristotle knew nothing) and asked: "How then can the heat be the origin of the veins?" According to Galen the veins arose from the liver and supplied the parts with nutritive blood. The heart, on the other hand, supplied the parts with spirituous blood. The little blood which passed from the right to the left side of the heart did so through invisible pores of the septum. In the left ventricle it became mixed with spirits and passed thence to the aorta and also to the lungs through the mitral valve, which, having but two leaves, was imperfect. The followers of Aristotle (called "philosophers") and those of Galen ("physicians") were soon at odds, each finding the weak points of the other's doctrine. In Galenism were the pores in the septum and the imperfection of the mitral valve; while, on the other hand, the tricuspid was the stumbling block of the Aristotelians.

By his discovery of the pulmonary path for the blood Columbus materially aided the Galenists, who might now abandon the idea that blood sweats through pores in the septum. When Harvey demonstrated the circulation and thus explained the use of the atrioventricular valves, he regarded himself as defending Aristotle's doctrine of the primacy of the heart and hence his remark regarding his opponent Riolanus, "It is proper that the dean of the College of Paris should keep the medicine of Galen in repair; and should admit no novelties into his school without the utmost winnowing."

Primacy of the Blood.—Aristotle believed that the heart was the center of life, the source of heat and the abode of the soul. But to the discoverer of the circulation the primacy of the heart began very early to give place to the primacy of the blood until in his latest utterances the heart is merely the servant of the blood, of use to pump it along but contributing to the blood nothing but motion. Harvey supported this novel view by observation. He believed that he saw in the chick embryo first the blood which presently began to pulsate by itself and only later the developing heart.

Aristotle had set forth a principle that those

parts which first manifest life are those which die last. Harvey thought this to be true of the blood, for he mistook the fibrillation of the auricle in the otherwise quiescent heart for an "obscure motion and flow and a sort of palpitation manifestly . . . in the blood itself," and furthermore he observed that animals without a pulse but which possess blood might continue to live.

Cause of the Heart Beat.—But Harvey was not willing to attribute to his new-found pump the importance which it deserved, as is seen from his views in regard to the cause of the heart's beat. To be sure, the most important cause of the return of the blood to the heart is the systole of the heart (and of the arteries) which continually stuff with blood the porosities of the parts. To this is added the muscular movements of the limbs, etc., and in the case of the pulmonary circulation the collapse of the lungs. But when it comes to the dilatation of the auricles the pump gives out and Harvey finds it necessary to endow the blood with a property (ebullition) borrowed from Aristotle. This dilatation of the auricles is an event of great importance to the circulation. Harvey saw in it, as we shall see, the cause of the heart beat. Aristotle knew nothing of contractility of muscle and was therefore obliged to attribute not only the diastole of the heart, but also its systole to the action of the blood which boiled, rising and falling within the heart. Since the time of Galen, however, the power of contraction had been recognized in muscle and consequently Harvey made use of this doctrine in interpreting the action of the heart. To Harvey the cause of the ventricular beat was the mechanical distension of the ventricle through the contraction of the auricle. But what distended the auricle? The power of ebullition of the hot blood (already referred to) acting "in the vena cava close to the base of the heart and to the right auricle." But how, we ask, did Harvey explain the simultaneous contraction of both auricles and how did he reconcile this view with the long-known fact (often referred to by him) that excised and bloodless hearts may continue to beat. In regard to the first, he only remarked that the simultaneous movement of the two eyes is a comparable phenomenon. But as to the second he says nothing whatever.

The Innate Heat.—Let us look more closely at the nature of the "innate heat" and "the soul" which Aristotle placed in the heart and Harvey in the blood. Aristotle was convinced that fire is sterile, while animal heat is generative and that therefore the heat of animals is quite distinct from elemental fire. In the simplest form of generation (the spontaneous) the soul is derived from the air and the heat from the sun. The solar heat is therefore generative and more akin to vital heat than to fire. Again, in sexual generation the vital heat and the soul are conveyed in the semen, but nevertheless the solar heat must be added "for the cause of man is his father, the sun, and the ecliptic" (that is the sun and its motions). The heat of animals is analogous to the ether, the fifth and superior element from which the heavenly bodies, including the sun, are made. But strangely inconsistent, he adds that the heat of the sun is born of friction and is not ethereal.

Harvey agrees with Aristotle that the animal heat is not fire nor derived from fire. He, too, believed that the sun in its motions generates acting through the semen of the male, that in generation the heat and soul are transmitted in the semen but find their abode during life not in the heart but in the blood.

We have seen that Harvey was no mere imitator of his great and revered master, Aristotle, that he was an observer and thinker of great originality and independence. It is equally interesting to note in closing his attitude toward the discoveries of others. The Copernican astronomy he treated as still *sub judice*. He paid no attention to the discovery by Aselli of the lacteals.

> He did not care for Chymistrey and was wont to speake against them (the chemists) with an undervalue.

In rejecting the view of Columbus he lost a valuable clue as to the nature of the respiration.

On reaching the end of this little volume one is seized with regret not only that the book

itself has come to an end, but that the work of the author is finished too. There are many who can carry forward investigations and complete new discoveries, but there are very few who are made competent by their thorough scholarship to understand, and through their delightful style to explain, the evolution of scientific thought from one age to another.

PERCY M. DAWSON

SPECIAL ARTICLES

THE PROCESS OF FEEDING IN THE OYSTER

A VALUABLE contribution to knowledge of the ciliary mechanisms of Lamellibranch mollusks has been made by James L. Kellogg in Vol. 26, No. 4, of the *Journal of Morphology*.

In this paper Dr. Kellogg brings together, with numerous illustrations, his observations on the ciliary tracts of structures found within the mantle chamber of thirty-one species of lamellibranchs.

In each case the observations were made on the animal after one of the valves of its shell had been removed, and the presence and direction of ciliary currents were determined by means of powdered carmine, fine black sand or masses of diatoms, deposited upon the parts under observation.

Among the several conclusions at which Dr. Kellogg arrives as a result of his study concerning the activities and functions of these tracts of cilia, the following, published on pages 699 and 700, are those to which the "oral exceptions," referred to by Dr. Kellogg on page 640, have been taken and they are the ones also which will be called in question in this paper:

1. Volume alone determines whether the collected foreign matter that reaches the palps shall proceed to the mouth or shall be sent from the body on outgoing tracts [of cilia].

2. A Lamellibranch is able to feed only when waters are comparatively clear—when diatoms are brought to the gill surfaces a few at a time. In muddy waters, all suspended particles, of whatever nature, are led to outgoing tracts.

3. There is no selection or separation of food organisms from other water-borne particles.

4. The direction of the beat of cilia is never changed.

The exceptions taken to these statements were not based, as Dr. Kellogg states, on the fact that the waters over Chesapeake oyster beds are normally muddy for long periods of time or upon the fact that the stomach contents of oysters always contain a larger volume of sand than of food organisms, although both of these facts are difficult to explain on the Kellogg theory, but they are based primarily upon the results of experiments, to be described later, which show that oysters can and do feed rapidly and continuously in waters that are turbid with sediment.

Before passing to a consideration of the results of these experiments, however, which bear directly upon the *first* and *second* only of Dr. Kellogg's conclusions (as numbered in this paper), reference may be made to the findings of other observers not in agreement with those of Dr. Kellogg, which indicate that the conclusions numbered (3) and (4) were possibly drawn from an insufficient basis of observation or that the methods of study employed by Dr. Kellogg were not designed to reveal *all* of the activities of the ciliary mechanisms of lamellibranchs.

REVERSAL OF CILIA AND FOOD SELECTION

In Stentor, Schaeffer[1] has shown that there is a selection of food particles brought about by changes in the beat of the cilia of the pouch and funnel, certain particles being rejected by a localized reversal of the cilia. He also found that the behavior of the animal toward food is not the same when it is in a condition of hunger as when in a condition of satiety.

Stentor is not an isolated example of protozoan possessing the power of food selection and rejection exercised through the control of the ciliary mechanism of the mouth region. Numerous other cases might be cited.

Cases of reversal of cilia are also reported among metazoan animals, Parker[2] having found that in *Metridium* the cilia on the lips, which normally beat outward, can be made to

[1] Asa Arthur Schaeffer, "Selection of Food in *Stentor cœruleus*," *Jour. Exp. Zool.*, 1910.

[2] G. H. Parker, "The Reversal of Ciliary Movements in Metazoans," *Am. Jour. of Physiology*, Vol. XIII., 1905.

reverse by stimulation with pieces or the juices of crab meat, these ciliary tracts thus constituting a mechanism through which the feeding process can be controlled.

In this paper Parker refers also to a number of papers, not easily available to the writer and not referred to by Dr. Kellogg, in which the reversal of ciliary movement in metazoans has been observed. Of special interest in this connection are those by Engelmann and others in which the *reversal* of cilia of the *palps of lamellibranchs* is described.

The only positive evidence I can offer for the conclusion that the oyster is able to select food is that afforded by a microscopic examination of its stomach contents. The various species of diatoms there found are not present in the same relative proportions as they exist in specimens of water collected in the vicinity of the bed from which the oyster fed. Furthermore, certain species of diatom (for example, *Rhizosolenia*), abundant in salt water, are seldom found in the alimentary tract of the oyster. The absence of these diatoms from the alimentary canal can hardly be due to their spiny structure because their size is not sufficiently great to prevent their being carried by ciliary currents or entering the mouth.

The observations that have been made of the reversal of the beat of cilia in both protozoa and metazoa, and of the ability of various animals to so control the movement of the cilia as to accept or reject food particles presented to them, at least suggest the possibility that the oyster may also have some power of food selection and that reversal of the cilia of certain tracts on the palps, resulting perhaps from their stimulation directly or indirectly by food particles, may be the mechanism by which the selection is effected.

Why, then, if a reversal of cilia and selection of food takes place in lamellibranchs, did so good an observer as Dr. Kellogg fail to see the reversal process? To me it seems clear that it was due to the fact that the animals on which he made his observations were, in every case, in a mutilated condition. In the case of his experiments on the oysters the shell was first removed and in its removal the adductor muscle was cut and the visceral ganglion, which is embedded in this muscle, was necessarily severely injured. Under such a condition of shock normal behavior is not to be expected, especially in the case of activities that may be subject to nervous control. The history of the animals experimented upon by Dr. Kellogg, whether they were in a state of hunger or satiety, was also unknown.

EXPERIMENTS

During the years 1909 and 1910 oysters planted on beds located in Buzzards Bay remained poor and the death rate among them was unusually large. Coincident with and following the same period, dredging operations were carried on in the vicinity of certain of these oyster beds which caused an unusual amount of sediment to be carried from the dredges across the oyster beds with the rising tides.

The oyster planters readily imagined that the poor condition and death of their oysters were in some way causally connected with this sediment in the water and they brought suit to recover their losses, with generous interest, from those responsible for the dredging operations.

During this litigation it has been the oral contention of Dr. Kellogg that, since the oysters planted on the beds located near the operating dredges were exposed on rising tides to unusually turbid water and since food-bearing sediment was therefore entering the mantle cavity of the oysters during these intervals in unusual abundance, the oysters were underfed and starved because the ciliated food-collecting mechanism of the palps must, under such conditions, transport the food-bearing material away from instead of to the mouth.

The ciliated food-collecting mechanism of the oyster is so constructed, according to the theory held by Dr. Kellogg, that it can transport food material to the mouth only when the food particles reach the ciliated tracts few at a time, for when they reach the palps more rapidly they are seized automatically by the cilia of outgoing tracts. It is an important part of his theory that the direction of the beat of the cilia composing the food-transporting mechan-

ism is non-reversible, hence his conclusion in this case that the oysters starved in the presence of an abundant supply of food. Although starving, the oysters were powerless to prevent the rejection of food material for the remarkable reason that the food material was reaching their feeding mechanism in embarrassing abundance.

It was not contended that the sediment was distasteful, for, in the organization of an animal with such a purely automatic feeding mechanism, what possible place could be found for so useless a thing as a sense of taste?

To test the validity of this contention the following experiments were carried out on the oyster beds where the oysters were said to have died from starvation, at a time when the waters were roiled and turbid from the operations of nearby dredges.

A considerable number of oysters of uniform size were first gathered from a bed far removed from the scene of the dredging operations. Five of them were immediately opened, their stomach contents removed and preserved in a vial for future study and analysis. The remaining oysters were thoroughly cleansed of all foreign material and stored for three days in a cool damp place. Twice each day they were placed for an hour in filtered sea water in order that they might expel from their shells the accumuated excreta. They were allowed to take no food. At the end of the third day of fasting, the primary object of which was to remove from the alimentary canal all previously ingested food material, the oysters were taken to a selected point on one of the oyster beds over which the sediment from the dredges was being carried by the rising tide and there, after five of them had been opened and their stomach contents removed, placed upon the bottom.

To facilitate depositing the oysters upon and removing them from the bottom, they were placed in a coarse-meshed wire tray to which cords were attached.

At the end of an hour from the time the oysters were deposited upon the bottom in the turbid water the tray was lifted for a moment, the stomach contents of five of the oysters were removed, and the tray with the remaining oysters returned to the bottom. At the end of the second hour this process was repeated and also at the end of the third hour. When the experiment was over the unused oysters were left upon the bottom in the tray for fourteen days to note the effect of the sediment upon them with the result that all thrived and made perceptible growth of shell.

The microscopic examination and estimate of the number of food organisms in the stomach contents taken from this series of oysters, which was made according to the "Rafter cell" method, resulted as follows:

Each oyster estimated to contain, when collected August 19, 10.30 A.M., 18,500 food particles.
Each oyster estimated to contain, after fasting till August 22, 1.30 P.M., 8,250 food particles.
Each oyster estimated to contain, after feeding 1 hour, August 22, 2.30 P.M., 11,500 food particles.
Each oyster estimated to contain, after feeding 2 hours, August 22, 3.30 P.M., 17,750 food particles.
Each oyster estimated to contain, after feeding 3 hours, August 22, 4.30 P.M.,[3]?

A second experiment in every way similar to the first, except that the oysters were subjected to a preliminary fast of four instead of three days' duration, was carried out between August 31 and September 4, 1911. The estimates of the stomach contents of the oysters used in this experiment are as follows:

Each oyster estimated to contain, when collected, August 31, 10 A.M., 12,125 food organisms.
Each oyster estimated to contain, after fasting till Sept. 4, 1 P.M., 2,850 food organisms.
Each oyster estimated to contain, after feeding 1 hour, Sept. 4, 2 P.M., 10,250 food organisms.
Each oyster estimated to contain, after feeding 2 hours, Sept. 4, 3 P.M., 16,500 food organisms.

RESULTS AND CONCLUSIONS

The results of these experiments show conclusively that oysters can and did feed actively in waters that were turbid with sediment, a fact that is in direct opposition to Dr. Kel-

[3] The food material removed from the stomachs of the oysters which had been feeding for three hours in the roiled water was so densely crowded with sediment that it was impossible to make the diatom counts necessary for an estimate of the total number of food organisms.

logg's conclusion, numbered (2) in this paper, and one that casts doubt upon the correctness of the three other conclusions herein discussed.

It is my belief that the results of the experiments and observations herein described when considered in connection with the observations of other investigators on various species of lamellibranchs and on various protozoa and metazoa, afford a satisfactory basis for concluding that the oyster is not the helpless automaton Dr. Kellogg makes it out to be, but that it possesses sufficient control over its ciliary feeding mechanism to prevent its starving in the presence of water-borne food material, even though the food particles and associated sand grains may be carried to its gills and palps in bewildering abundance.

This control of the feeding mechanism and the ability to select food may conceivably be exercised through control of the direction of the effective beat of the cilia of certain tracts on the palp surfaces and, since reversal in the stroke of cilia on the palps (nebenkiemen) of lamellibranchs has actually been observed by Engelmann and others, and since selection and rejection of foreign particles through control of ciliary movement have been observed in various animals (*Stentor, Metridium, etc.*), we may well expect to find that the oyster exercises control over its feeding processes through ability to change the direction of the effective stroke of the cilia of certain tracts on its palps.

Caswell Grave
Johns Hopkins University,
Baltimore, Md.

THE AMERICAN ASSOCIATION OF MUSEUMS

The American Association of Museums held its eleventh annual meeting in Washington, D. C., May 15–18. The opening session was devoted to the transaction of business, and to a special report by Secretary Paul M. Rea on the "Condition and Needs of American Museums." This report summarized the work of the association during the past ten years, reviewed the studies of American museums which have been made on behalf of the association, and outlined the work which might be undertaken for the furtherance of museum development.

The evening of May 15 was devoted to a supper in celebration of the decennial of the American Association of Museums. Following this supper the presidential address was given by Dr. Oliver C. Farrington on "Some Relations of Art and Science in Museums." The remainder of the evening was occupied with informal remarks by members of the association. This session was presided over by Dr. W. J. Holland, of the Carnegie Museum, who was one of the founders of the association and its third president.

At the morning session on May 16 a group of papers was presented reporting progress in a concerted experiment by several museums in the use of museums for instruction in the history of civilization. This symposium was arranged by Miss Anna D. Slocum, acting on behalf of the association in cooperation with the Woman's Education Association of Boston. The titles of the papers were as follows:

"A Study of Nations through the Museum," by Miss Anna D. Slocum.

"History Study and Museum Exhibits," by Miss Delia I. Griffin.

"Museum Stories of Art and Civilization," by Miss Margaret E. Sawtelle.

"The Museum Story as an Introduction to History," by Mrs. Laura W. L. Scales.

"Teaching History in the Museum," by Mrs. Agnes L. Vaughan.

"The Museum and the School," by Miss Lotta A. Clark.

Other papers presented at this session were "A Museum Game," by Miss Eva W. Magoon, and a paper on the "Development of the N. W. Harris Public School Extension of the Field Museum of Natural History," by Mr. S. C. Simms. Miss Viola M. Bell, of Teachers College, Columbia University, presented by invitation a paper on "Relations of Domestic Science Teaching to Museums." Following these papers the association proceeded to the election of officers with the following result:

President, Henry R. Howland, Buffalo Society of Natural Sciences.

Vice-president, Newton H. Carpenter, Art Institute of Chicago.

Secretary, Paul M. Rea, The Charleston Museum (S. C.).

Treasurer, W. P. Wilson, The Philadelphia Museums.

Assistant Secretary, Laura L. Weeks, The Charleston Museum (S. C.)

The retiring president, Dr. Oliver C. Farrington,

of the Field Museum of Natural History in Chicago, and Mr. Harold L. Madison, of the Park Museum in Providence, became members of the council.

The session of Tuesday afternoon, May 16, was presided over by Mr. Henry W. Kent, of the Metropolitan Museum of Art, and was devoted to a discussion of instruction service in museums. The following papers were presented:

Introduction, by Mrs. Agnes L. Vaughan.

"Exhibitions of Children's Drawings," by Mrs. Jeannette M. Diven.

"Courses offered by Museums," by Dr. G. Clyde Fisher.

"Required Reading and Reviews," by Miss Alice W. Wilcox.

"School Credits," by Mr. William L. Fisher.

"Experimental Examinations," by Miss Agnes L. Pollard.

"Connections with Colleges," by Mrs. Laura W. L. Scales and Mr. William L. Fisher.

The evening session of May 16 was devoted to a consideration of the relations of museums with the public. The following papers were presented:

"A New Form of Museum Advertising," by Mr. Herbert E. Sargent.

"Advertising an Art Museum," by Miss Margaret T. Jackson.

"How the Art Institute of Chicago has Increased its Usefulness," by Mr. Newton H. Carpenter.

"Increasing the Usefulness of Museums," by Mr. John C. Dana.

At the morning session of May 17 the following papers dealing with museum methods were presented:

"The MacLean Museum Case," by Mr. L. Earle Rowe. (Illustrated.)

"Museum Exhibition Cases," by Mr. Harold L. Madison. (Illustrated.)

"Index Labels," by Mr. Roy W. Miner. (Illustrated.)

"A New Development in Museum Groups," by Mr. Dwight Franklin. (Illustrated.)

"Some New Installation of Industrial Material," by Mr. William L. Fisher. (Illustrated.)

"Installation of Textile Fabrics," by Mr. Frederick L. Lewton.

"Installation of Ethnological Material," by Dr. Walter Hough.

"Suggestions for a Forestry Exhibit," by Dr. A. R. Crook.

In the afternoon of May 17 the association met with the American Federation of Arts, Dr. Edward Robinson, of the Metropolitan Museum of Art, presiding. The subject of discussion was The Art Museum and the People. The following papers were presented:

"The Story Method of Instruction," by Miss Margaret E. Sawtelle.

"A Small Museum and its Value to a Community," by Mr. J. G. Butler, Jr.

"A National Museum and School of Art," by Mr. Henry Tupper Bailey.

Wednesday evening, May 17, the regents and secretary of the Smithsonian Institution tendered a reception to the American Association of Museums and to the American Federation of Arts.

At the concluding session on Thursday, May 18, the following papers were presented:

"The Correlation of Art and Science in the Museum," by Professor Homer R. Dill.

"Administrative Organization," by Mr. Benj. Ives Gilman.

In discussing the future work of the association a general desire was expressed for the publication of a museum journal to replace the annual volume of *Proceedings*. This and other suggestions regarding future work were referred to the council for consideration.

A movement to secure a larger representation of the trustees of museums in the membership of the association was begun at the San Francisco meeting last year. Further discussion of this subject took place at Washington, and a committee was appointed to bring to the attention of museum trustees the intimate relation of the work of the association to the welfare of their institutions.

Other committees were appointed as follows:

A committee to consider a communication of the College Art Association with reference to the development of adequate training for museum workers.

A committee to consider methods of cooperation with the American Federation of Arts.

A committee to consider the possibility of cooperation between museums and the Forest Service in illustrating the principles of forestry by museum exhibits.

Invitations for the 1917 meeting of the association were received from museums in Springfield (Mass.), New York City and Philadelphia. A vote of appreciation and thanks was extended to these museums, and the final decision referred to the council.

PAUL M. REA,
Secretary

SCIENCE

FRIDAY, AUGUST 11, 1916

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

RECENT PROGRESS IN OUR KNOWLEDGE OF THE PHYSIOLOGICAL ACTION OF ATMOSPHERIC CONDITIONS[1]

Two weeks ago to-day, in the physiological laboratory of the Columbia School of Medicine, Dr. Fred W. Eastman and I made the following experiment: A young man, twenty-one years of age, in excellent physical condition, who was willing to act as the subject of our tests, was dressed in light underclothing and light trousers, a sweater, stockings and shoes. His systolic and diastolic blood pressures and his pulse rate were taken in the sitting posture; the carbon-dioxide content of the alveolar air of his lungs was determined; a pneumograph was attached to his chest for recording his respiratory movements; a resistance thermometer was placed in the rectum and connected with a self-writing galvanometer for the continued record of his bodily temperature; and a flat-bulbed thermometer was strapped firmly to his forehead to serve as an indicator of the temperature of his skin. Thus equipped he entered a small chamber, provided with a door and windows and with facilities for heating and humidifying the air. He remained there, sitting quietly, for a period of four and one quarter hours. The temperature of the air in the chamber was raised as quickly as possible above the temperature of his body and reached a maximum of 43.3° C. (110° F.) with a maximum wet-bulb reading of 37.2° C. (99° F.), while the relative humidity was increased to a maximum of 85 per

[1] Read before the American Pediatric Society, Washington, D. C., May 8, 1916.

cent. For a period of two and one quarter hours the door of the chamber was kept closed, although it was not wholly air-tight, and the unusual atmospheric conditions were maintained, although not continually at their maximum. Afterward the door of the chamber was opened and the air within was allowed to acquire the more comfortable conditions of the room air outside, which possessed a temperature of 18° C. (64.5° F.) and a relative humidity of 51 per cent. During the whole time of the experiment a continuous record was made of the subject's bodily temperature; at intervals of fifteen minutes measurements were made of the temperature and the humidity of the air of the chamber, of the temperature of the subject's mouth and of the skin of his forehead, and of the rate of his pulse and his respiration; at intervals of every hour his systolic and diastolic blood pressures and the carbon dioxide content of his alveolar air were determined; while occasional records were made of the carbon dioxide content of the air of the chamber and of the subject's sensations. The results of the experiment will be discussed later. It is typical of many experiments, similar in object although differing in details, which have been performed in recent years inside and outside many laboratories in an endeavor to discover the relations of the individual to the air that surrounds him.

As one result of these experiments there has been a great change in our ideas concerning the physiological action of atmospheric conditions. It had long been the custom to ascribe to chemical components of the atmosphere the bad effects of living in air that had already been breathed by human beings. The discovery of oxygen and of carbon dioxide early in the last century gave a great stimulus to this notion, and it became firmly fixed in the minds of chemists, physiologists and physicians, as well as the educated masses, that air that had been breathed was vitiated chemically and rendered unfit for human use by the lack of oxygen, the accumulation of carbon dioxide, and the presence of an organic poison of unknown nature. No sooner had this notion become widely accepted than the laboratories began to demonstrate the inadequacy of the supposed proof of the notion, and—to cut a long story short—we now know that, except under very unusual circumstances, the harmfulness of respired air is not due to its chemical components. By respiration oxygen can not be reduced to a deleterious proportion nor can carbon dioxide be produced in deleterious quantity, except under very unusual conditions of living; and the organic poison of respiration has no real existence. The harmfulness of living in confined air is found in certain physical rather than chemical features—the air is too warm, too moist, and too still; and if it has not these physical features it is not harmful.

We all have sat in crowded assemblies; we all have experienced the hot, humid, still days of an American summer. We all know the effects of such air on our sensations—the general bodily discomfort, the sleepiness, the flushed face, the headache, the disinclination to think or to act, the general debility, the longing for relief. But sensations are an inadequate measure of bodily conditions. In what respects is hot, humid, still air harmful? To answer this question we must consult the records of many researches, chiefly on human beings, but partly on animals, that have been undertaken since Hermans,[2] more than thirty years ago, observed that in crowded theaters and churches his own bodily temperature rose. The most recent of these researches is that of the New York State

[2] Hermans, *Arch. f. Hyg.*, I., 1, 1883.

Commission on Ventilation,[3] which has been in progress for the past two and one half years and is not yet completed.

Notwithstanding that man is supposed to be a homothermal organism, there is a certain relationship between his bodily temperature and the temperature of his environment, even under the ordinary conditions of living. This has been shown by the New York Commission, which found that during the months of June and July the rectal temperature of its subjects at 8 A.M., living in their own homes, was conditioned by the average atmospheric temperature of the preceding night. If the night had been warm the bodily temperature in the morning was high; if cool, the bodily temperature was low. The variation of bodily temperature was about 0.55 degrees C. (1 degree F.) for 20 degrees of atmospheric temperature, although it is probable that the degree of variation can be modified by the clothing. The commission further found that, whatever the bodily temperature of its subjects might be at the beginning of an experiment, it was lowered by confinement in an atmosphere of 20° C. (68° F.) and 50 per cent. relative humidity, and raised by confinement at 23.9° C. (75° F.) with the same humidity, or still more by 30° C. (86° F.) with 80 per cent. humidity. The final average bodily temperatures in certain series of observations, where the subjects were confined in the observation chamber for from 4 to 7 hours were as follows:

After 20° C. (68° F.), 50 per cent. humidity, the average bodily temperature was 36.7° C. (98° F.).

After 23.9° C. (75° F.), 50 per cent. humidity, the average bodily temperature was 36.9° C. (98.5° F.).

After 30° C. (86° F.), 80 per cent. humidity, the average bodily temperature was 37.4° C. (99.3° F.).

Haldane[4] and others have shown a greater elevation of bodily temperature in more extreme atmospheric conditions, and have pointed out the accompanying dangers of heat stroke. Eastman and I have seen the temperature of a normal adult man rise 3.3° C. (6° F.) during a stay of three and one quarter hours in an atmosphere averaging 40.4° C. (104.7° F.) in temperature and 95 per cent. in relative humidity. The relation between bodily temperature and external cold has not been so fully studied, but enough is known to warrant the statement that, in normal individuals at least, the bodily temperature can be to a considerable degree controlled by controlling the temperature and the humidity of the surrounding air. It is altogether probable that the same is largely true in febrile diseases.

External temperature exerts likewise a definite effect on the circulatory system. The rate of the heart beat is increased in warm, humid, and decreased in cool, dry air. The New York Commission found the average rate of its subjects confined in an atmosphere of 30° C. (86° F.) and 80 per cent. relative humidity to be 74, and in an atmosphere of 20° C. (68° F.) and 50 per cent. humidity to be 66. Eastman and I have seen the pulse rate increase by 39—from 67 to 106—as the temperature of the air surrounding the subject rose from 23.3° to 43.3° C. (74° to 110° F.) and the humidity from 58 to 90 per cent.

The important and involved topic of the

[3] C.-E. A. Winslow (chairman), D. D. Kimball, Frederic S. Lee, J. A. Miller, Earle B. Phelps, E. L. Thorndike and G. T. Palmer (chief of investigating staff). The results of their investigations have yet been published only in part. For a general presentation of some of the results see *Am. Jour. of Public Health*, V., 85, 1915.

[4] Haldane, *Jour. Hyg.*, V., 494, 1905. Haldane, Pembrey, Collis, Boycott and Cadman, Rep. Dept. Com. on Humidity and Ventilation in Cotton Weaving Sheds, London, 1909 and 1911.

relation of atmospheric conditions to blood pressure I must leave until the abundant data that have been accumulated by the New York Commission have been subjected to a more careful examination than has yet been possible, although it may be said that excessively high temperatures and high humidities are accompanied by an elevation of both systolic and diastolic pressures. A study of the commission's records by one of the various methods for evaluating vascular data seems to reveal another fact of distinct importance. When the human body rises from a recumbent to a vertical position the threatened settling of the blood into the lower parts by gravity, with the resultant deleterious effects, ought obviously to be counteracted. In the healthy person the most expedient way to accomplish this is by means of a vigorous vasomotor mechanism acting to constrict the arterioles and raise the blood pressure. This mechanism is assisted by a quickening of the rate of the heart's beat. If the mechanism be enfeebled from any cause, there may be, along with the change of posture, a lessened rise of blood pressure, or even a fall, and a great increase in the heart rate. A comparison, therefore, of the change in the systolic blood pressure and the change in the rate of the pulse resulting from a change of the position of the body from the horizontal to the vertical gives a clue to the efficiency of the vasomotor mechanism. On this basis Crampton[5] has constructed a scale of percentages of vasotone. In terms of this scale the New York Commission finds that the vasotone diminishes in hot and humid air, and increases as the air becomes cooler and dryer. Thus these results indicate that a distinct vascular benefit follows from exposing the body to a cool dry air.

Atmospheric conditions exert on the respiratory system effects of various kinds. On the rate of respiration a moderate degree of heat and humidity seems to be without effect, but more extreme conditions cause a quickening of the breathing, and this is probably accompanied by more shallow respirations. The more extreme conditions too appear to result in a lowered concentration of carbon dioxide in the air of the pulmonary alveoli, although I can not yet quote actual figures to demonstrate this. The matter, however, is important, since a lowered alveolar carbon dioxide may signify an increased content of hydrogen ions, in other words increased acidity, in the blood. Eastman and I are now investigating this point with much interest.

The mucous membrane of the respiratory tract is markedly affected by atmospheric conditions. This was shown three years ago by Hill and Meucke,[6] and it has recently been quite fully investigated by Miller and Cocks[7] under the auspices of the New York Commission. Exposure to heat causes increased swelling, redness and secretion in the nasal mucosa, and these effects are more marked when the humidity of the air is high. Exposure to cold reverses the effects. When the subject passes from a cool to a hot room and a current of air is played upon the face there occurs a diminution of the swelling and the secretion; but passage from a hot to a cool room with a similar draught results in increased swelling and increased secretion. This latter condition seems to be especially favorable for the development of infectious microorganisms. But the causative relation of the bacteria of the nasal mucosa to "colds" seems to be still in doubt.

The distaste for physical labor which we feel on a hot humid day is a common experi-

[5] Crampton, *New York Med. Jour.*, 98, 916, 1913.

[6] Hill and Meucke, *Lancet*, 1291, 1913.

[7] Miller and Cocks, *Trans. Am. Climatol. and Clin. Assoc.*, 1915.

ence, and it is often interpreted as real inability to work. The New York Commission found, in their experiments with human beings, that, if pushed, the individual is capable of performing as much muscular work in an atmosphere of 30° C. (86° F.) and 80 per cent. relative humidity as in one of 20° C. (68° F.) and 50 per cent. humidity, but that he is not inclined to do so much. The lack of exact knowledge as to what the muscles themselves apart from the nervous system can do under such circumstances induced Scott and myself[8] to investigate the subject on animals. Taking the comfortable condition of 20.6° C. (69° F.) with 52 per cent. relative humidity as our standard, we found that when cats were confined for six hours in a well-ventilated chamber, the air of which was kept at an average temperature of 32.8° C. (91° F.) and an average humidity of 90 per cent., the excised muscles of the animals lost in the length of their working period before exhaustion 11 per cent. and in the total amount of work which they were able to perform 24 per cent. At an intermediate temperature and humidity they lost in an intermediate degree. These results indicate that the distaste for physical labor which is felt on a hot and humid day has a deeper basis than mere inclination—the muscles themselves are actually incapable of performing as much work. We found, moreover, that in the extreme condition the blood lost as much as 6 per cent. of its sugar, and 2 per cent. when the intermediate condition was maintained. There is evidently correlation between decreased blood sugar and decreased muscular power, and we have suggested that a physiological adaptation is here indicated, such that "when it is physiologically fitting that the animal reduce muscular exertion to a minimum, in order that the output of heat may be as low as possible, as in a hot and humid environment, the supply of fuel will be lowered correspondingly."

[8] Lee and Scott, *Am. Jour. of Physiol.*, XL., 486, 1916.

Little can be said at present regarding the action of atmospheric conditions on the nervous system. The rise of external temperature by dilating the cutaneous blood vessels undoubtedly makes the brain anemic, but it is not certain that variations in such temperature with or without variations in humidity markedly affect the action of the nerve tissues, unless the variations are excessive. The New York Commission, under the lead of Thorndike, has expended much time and effort in endeavors to detect a possible influence of atmospheric variations between moderate limits on the ability to do mental work. The subjects were given such psychological tests as cancelling arithmetical figures, adding figures, mentally multiplying three-place by three-place figures, typewriting, and more complex mental performances which involve choice and judgment. The range of atmospheric variation was from a lower limit of 20° C. (68° F.) and 50 per cent. relative humidity, and an upper limit of 30° C. (86° F.) and 80 per cent. humidity. In some cases the air was quiet, in others it was kept in motion by electric fans. The tests continued for periods of from 4 to 7 hours and in some cases they were repeated for 6 successive days under the same conditions. In neither the young men nor the young women subjects of these tests could there be detected any relation between atmospheric conditions and either the accuracy or the amount of the mental work that was performed. A series of experiments on a larger scale has been instituted, but is not yet completed.

The relation between atmospheric conditions and metabolic phenomena is not yet elucidated. During the summer of 1914 the

New York Commission made a partial study of this topic on human beings with the assistance of Mr. H. L. Higgins, then of the Carnegie Nutrition Laboratory. The tests employed included such subjects as total metabolism or total heat production, the metabolism of carbohydrate, and the metabolism of protein. The results were almost wholly negative. They can not, however, be regarded as conclusive. As regards lesser specific changes in metabolic processes, too, little can be said at present. But the facts that external cold increases metabolism, that profound metabolic changes occur in the fevers of infection and that there is some evidence that in hyperthermy produced in other ways than by infections metabolism is altered, lead us to suspect that it may be changed, not only totally but in specific details, with even moderate changes in the surrounding atmosphere. It is difficult to believe that a relationship that is so amply demonstrated for the physical phenomena of the body does not involve also its chemical performances.

A further topic that is inviting is the possible relationship between atmospheric conditions and bacterial infections. Most of the experimental observations that have here been made relate especially to the action of temperature on the course of infections, and it has generally been found that high external temperature with accompanying pronounced increase of bodily temperature checks the progress of infections that are already existing. Somewhat lower temperatures (30°–35° C., 86°–95° F.) on the other hand, seem to favor the multiplication of the bacteria and the advance of the disease. In the experiments of Winslow, Miller and Noble,[9] of the New York Commission, in which rabbits were confined in air of from 29° to 32° C. (84.2°–89.6° F.) there was, in the first three weeks, a distinct decrease in the formation of hemolysins when the animals were compared with control animals kept at lower room temperatures. Similar but less striking results were obtained in the formation of agglutinins.[10] It thus appears that external temperatures up to about 30° C. (86° F.) are unfavorable to the development of immune bodies in the blood. Miller and Noble,[11] of the New York Commission, found, furthermore, that respiratory infections of rabbits with *Bacillus bovisepticum* (snuffles) is favored by the chilling of such animals after they have been accustomed to heat, and some of their results suggest that a change from a low to a high external temperature also predisposes to similar infection. Although Chodounsky[12] obtained only negative results, the weight of the recent experimental evidence favors the view that exposure of the body to cold is favorable to the incidence of acute respiratory disease, and it appears not improbable that the primary seat of this deleterious influence is in the mucous membrane of the upper air passages.

No review of recent progress in our knowledge of the relation of man to the atmosphere would be complete if it failed to take note of the striking observations of Mr. Ellsworth Huntington, which are set forth in his engaging book on "Civilization and Climate."[13] Mr. Huntington made a careful study of the output of industrial workers in various factories in the state of

9 Winslow, Miller and Noble, *Proc. Soc. Exp. Biol. and Med.*, XIII., 93, 1916.

10 Winslow, Miller and Noble, *Proc. Soc. Exp. Biol. and Med.*, XIII., 1916.

11 Miller and Noble, "The Effects of Exposure to Cold Upon Experimental Infection of the Respiratory Tract." Not yet published.

12 Chodounsky, "Erkaltung und Erkältungskrankheiten," Wien, 1907.

13 Huntington, "Civilization and Climate," New Haven, 1915.

Connecticut, as determined by their monthly wages for piece work, over a period of four years. He found that the annual course of production was as follows: Low at the beginning of the calendar year, it fell still lower and reached its minimum at about the end of January; through the spring there was a gradual increase in output until June; then a moderate decrease until the end of July; in the autumn an increase to the maximum in November; and then the winter descent to the succeeding January minimum. Production was thus greatest in the spring and the autumn, and least in the winter and the summer. A very similar course was followed by the workers engaged in making electrical apparatus in Pittsburgh; and similar confirmation of the validity of the conclusions, with changes in details, was made by the output of other industrial workers in the southern states and by strength-tests of school children in Denmark. All these data combine to demonstrate that the greatest physical efficiency of the individual is found not during the summer or the winter, but at intermediate seasons. That the same is true also of mental activity is shown by a study of the marks secured by the students at West Point and Annapolis in certain classes, especially mathematics. Of the various climatic features of the different seasons that might be responsible for these seasonal differences in achievement, temperature appears to be the most important. Both physical and mental activity seem to be greatest and most effective, not when extreme summer's heat or extreme winter's cold prevails, but when the body is subjected to an intermediate temperature. After a careful consideration of his many figures Huntington came to the conclusion that the optimum temperature of the outside air for the physical work of human beings is about 60° F. (15.6° C.) and for the mental work about 40° F. (4.4° C.) the greatest total efficiency of the human body culminating at the intermediate point of 50° F. (10° C.).

We have thus seen that the body reacts to changes in atmospheric conditions in manifold ways. The most potent of the atmospheric agencies is undoubtedly temperature, but high temperatures exert greater effects when they are accompanied by high humidity. I have said little of the movement of air, but it should be understood that movement is an important agency, and its share in the physiological phenomena has been studied by the New York Commission. By way of general summary it may be said that when an existing external temperature is fairly comfortable to the individual an elevation of it, especially when such elevation is accompanied by an increase of humidity, is deleterious, and the deleterious effects are more pronounced when the air is stagnant. Deleterious effects resulting from such a combination of atmospheric conditions may be in some degree obviated if the air next the skin be put into motion, but a more effective antidote is a reduction in the temperature of the air, and this may be assisted by a reduction in its humidity. All experimentation and observation go to demonstrate that a moderately cool and moderately dry air in motion constitutes the most physiologically helpful aerial envelope of the body. The customary figure of 70° F. (approximately 21° C.) for the atmosphere in which most persons engage in the ordinary occupations of the living room of a dwelling is too high; a range from 65° to 68° F. (approximately 18°–20° C.) with not over 50 per cent. relative humidity, is undoubtedly better, but even such temperatures are too high when much physical activity occurs. Depending on activity and on more obscure corporeal conditions the same external temperature may feel at one time warm and at

another time cold. The degree of comfort that is felt—which should not be allowed too potent an influence in deciding what one's environmental conditions shall be—depends, moreover, largely on the thickness of the clothing and on habit. It is surprising how readily one's habits in this respect may be altered. Uniformity in conditions should be avoided; too long a continuance of an existing temperature is dulling to the body; there should be not infrequent and marked changes. Artificial ventilating systems should not necessarily be condemned, but should be operated intelligently and may advantageously be combined with window ventilation.

In these days we hear much of "fresh" air and its merits. We have fresh-air funds, fresh-air schools, and fresh-air babies. All are commendable; but while giving to our funds, opening our schools, and putting our babies out of doors, let us clearly understand what constitutes fresh air. The freshness of so-called "fresh" air lies, not in more oxygen, less carbon dioxide, less organic matter of respiratory origin, and the hypothetical presence of a hypothetically stimulating ozone, but rather in a low temperature, a low humidity, and motion. So far as fresh air itself is concerned, there seems to be nothing more mysterious about it than this.

To what extent ought fresh air to be used as a therapeutic agent? Here intelligent experience, and not opinion without experience, is the only guide. That a physician, indeed, should have any article in his creed of therapeutics that is not based on the intelligent experience of somebody is not to be supposed. It can not be denied that where intelligent experience has been applied to the topic of fresh air as a therapeutic agent the use of fresh air has been almost invariably extended. But no one has a right to maintain, therefore, that it is a panacea. Only when it has been tested in a great variety of pathological conditions—and this can be done with entire safety to the patient—will the therapeutic use and limitations of this physiologically significant agent become known.

Frederic S. Lee

Columbia University

THE ORIGIN OF THE PRE-COLUMBIAN CIVILIZATION OF AMERICA

In the whole range of ethnological discussion perhaps no theme has evoked livelier controversies and excited more widespread interest than the problems involved in the mysteries of the wonderful civilization that revealed itself to the astonished Spaniards on their first arrival in America.

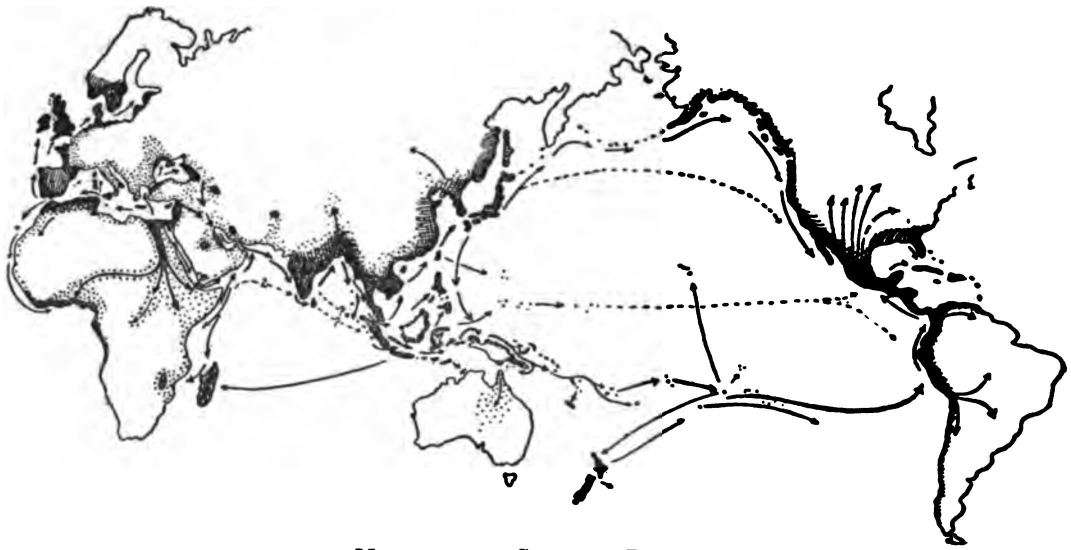
During the last century, which can be regarded as covering the whole period of scientific investigation in anthropology, the opinions of those who have devoted attention to such enquiries have undergone the strangest fluctuations. If one delves into the anthropological journals of forty or fifty years ago they will be found to abound in careful studies on the part of many of the leading ethnologists of the time, demonstrating, apparently in a convincing and unquestionable manner, the spread of curious customs or beliefs from the Old World to the New. Then an element of doubt began to creep into the attitude of many ethnologists, which gradually stiffened until it set into the rigid dogma—there is no other term for it—that as the result of "the similarity of the working of the human mind" similar needs and like circumstances will lead various isolated groups of men in a similar phase of culture independently one of the other to invent similar arts and crafts, and to evolve identical beliefs. The modern generation of ethnologists has thoughtlessly seized hold of this creed and used it as a soporific drug against the need for mental exertion. For

when any cultural resemblance is discovered there is no incentive on the part of those whose faculties have been so lulled to sleep to seek for an explanation: all that is necessary is to murmur the incantation and bow the knee to a fetish certainly no less puerile and unsatisfying than that of an African negro. It does not seem to occur to most modern ethnologists that the whole teaching of history is fatal to the idea of inventions being made independently. Originality is one of the rarest manifestations of human faculty. For many centuries countless millions of men must have witnessed the effects of steam before the simple and obvious inference was made and it was put to a mechanical use; but if, not knowing the history of the invention of the steam engine, we were to adopt the stereotyped ethnological doctrines of the present day the wide geographical distribution of the steam-engine should be regarded as a most striking illustration of the "similarity of the working of the human mind." Nor does it appear to have struck the orthodox ethnologist that his so-called "psychological" explanation and the meaningless phrase "similarity of the working of the human mind" run counter to all the teaching of modern psychology. For it is the outstanding feature of human instincts that they are extremely generalized and vaguely defined, and not of the precise and highly-specialized character which modern ethnological speculation attributes to them. Nor again is the case strengthened by the misuse of the word "evolution," for the independent development of such an artificial confection as civilization postulates the existence of factors utterly alien to the biologist's conception of evolution.

Why then, it will be asked, in the face of the overwhelming mass of definite and well-authenticated evidence clearly pointing to the sources in the Old World from which American civilization sprung, do so many ethnologists refuse to accept the clear and obvious meaning of the facts and resort to such childish subterfuges as I have mentioned?

Putting aside the influence of Darwin's work, the misunderstanding of which, as Huxley remarked, "led shallow persons to talk nonsense in the name of anthropological science," the main factor in blinding so many investigators to appreciate the significance of the data they themselves so laboriously collect results from a defect incidental to the nature of their researches. The intensive study of a localized area reveals difficulties in explaining every stage in the process of transmission of customs from one spot to another, which the investigator is apt to magnify into insuperable obstacles against the view that the practises or beliefs in question did spread. The failure to recognize the fact, recently demonstrated so convincingly by Dr. Rivers, that useful arts are often lost is another, and perhaps the chief, difficulty that has stood in the way of an adequate appreciation of the history of the spread of civilization.

Bearing these considerations in mind and turning to the positive evidence that establishes the reality of the migrations of culture-bearing peoples, it will be found that there is now available a vast mass of precise and unquestionable testimony in substantiation of the conclusion that the curiously distinctive culture-complex which was gradually built up in Egypt between the years B.C. 4,000 and B.C. 900 began to be widely diffused, at some time after the latter date, west, south and east, and that the latter (the easterly migration), with many additions and modifications which it received on the way (in the Soudan, East Africa, and Arabia; in the eastern Mediterranean, Phœnicia, Armenia and Babylonia;



Map showing Cultural Routes

in India, Ceylon, Burma and the Malay Peninsula; in Indonesia and China; and finally in Polynesia) ultimately reached the Pacific coast of the Americas and leavened the aboriginal population of the vast continent with the ferment of the ancient civilizations of the Old World.

During the thirty centuries from B.C. 4,000 onwards there was built up slowly in Egypt, partly as the result of a natural and logical development, but also in part by the accidental addition of many foreign elements, a cultural fabric of a peculiarly complex and artificial texture, the pattern of which is so distinctive that it can be identified wherever and under whatsoever circumstances it occurs.

A people who in B.C. 4,000 were already acquainted with the art of weaving linen, and who practised the curious rite of circumcision, a few centuries later learned to appreciate the usefulness of metals and invented the elements of the metallurgical arts and crafts. It was the merest chance that this particular group of people should have been led by force of circumstances to have been impelled to mummify their dead. But intimately interwoven with the development of the art of embalming and casually related to it was the making of rock-cut tombs and the building of stone superstructures, the possibility of the making of which was suggested by the use of metal tools. The use of linen was also closely related to these developments. Thus the accidental association of a series of naturally disparate factors became welded about B.C. 3,000 into the nucleus of a peculiar culture of which mummification, the making of rock-cut tombs and a great variety of megalithic monuments, the use of copper and gold and the weaving of linen, and the practise of the rite of circumcision, were some of the outstanding features.

In connection with the ritual associated with mummification statues of the deceased were made and a crop of curious beliefs and rites developed. Thus originated the belief in the indwelling of human beings in stones, and the possibility of petrifying men and animals, the rites of incense-burning and offering libations, and a whole series of other bizarre practises and beliefs, which later became so widespread as in

some measure to seem to justify the prevalent conviction that they were independent expressions of a common human instinct.

It was the merest chance that the people amongst whom this remarkable culture-complex was gradually being built up should have been sun-worshipers, and that the particular group amongst whom the royal family of Egypt originated regarded the Horus-hawk as the symbol of their royalty. It was no less fortuitous that the seat of the capital after the first unification of Egypt should have been in a place (Buto) where the uræus-serpent was venerated. Thus there is the clearest evidence that the complex symbolism of the Sun-god—the sun's disc, the serpent and the hawk's wings—is purely a chance association which was established in Egypt. The intimate connection of sun-worship and its peculiar symbolism with megalithic monuments, with mummification, and with the conception of the king as the son of the god are equally fortuitous associations.

It was no less a chance that this distinctive culture-complex was built up amongst an agricultural people who by force of circumstances were expert in a peculiar method of irrigation.

In the times of the New Empire (from B.C. 1,600 onward) a great variety of accidental accretions were made to this complicated type of civilization which for long centuries had been growing up in Egypt. Such practises as piercing the ears, and a remarkable series of new tricks in the embalmer's technique, are examples of the innovations, some of which are so definite as to enable us to state that the type of Egyptian culture-complex which was distributed so widely in the world could not have started on its wanderings before B.C. 900 at the earliest. It was probably at least a century later before the great migration left the African shores.

It reached the Persian Gulf by various routes. The fact that it passed up the Nile, through Nubia and the Soudan, thence by East Africa and the Arabian coast, is proved by a large series of Ethiopian accretions to and modifications of Egyptian practises when they appear in India and farther east. There are historical reasons for believing that a good deal of intercourse took place via the Red Sea and the Arabian littoral.

The transmission of a number of Mediterranean customs, such as the use of pearls, *Purpura* and conch-shell trumpets, and certain peculiar modifications of embalming indicate the influence of the Levant. The use of the Swastika-symbol, the peculiarly distinctive Black Sea type of dolmen, and the Armenian custom of skull deformation, are further tokens of the part taken by western Asia in adding to and modifying the purely Egyptian contributions to the strange cargoes these ancient mariners carried to India. There are also manifold witnesses of the influence of Babylonia, not only in modifying the Egyptian architectural ideas of the wanderers, but also in contributing new ideas and beliefs. An example is the greater definiteness assumed by the story of the creation, the deluge, the destruction of the sons of men by petrifaction, and the perpetuation of the chosen race by incestuous unions.

This cultural stream from the Persian Gulf to the Indian coast probably began at the end of the eighth century B.C. and persisted for many centuries; and the Pre-Aryan population of India became thoroughly leavened with its potent influence. Ceylon and further India, Burma and the Malay Archipelago, in turn were brought within the sphere of its activities, probably as early as the sixth and fifth centuries B.C.

From Indonesia the whole eastern Asiatic littoral and all the neighboring islands were

stirred by the new ideas; and civilizations bearing the distinctive marks of the culture-complex which I have traced from Egypt sprang up in Cochin-China, China, Corea, Japan and eventually in all the islands of the Pacific and the western coast of America. The proof of the reality of this great migration of culture is provided not merely by the identical geographical distribution of a very extensive series of curiously distinctive, and often utterly bizarre, customs and beliefs, the precise dates and circumstances of the origin of which are known in their parent countries; but the fact that these strange ingredients are compounded in a definite and highly complex manner to form an artificial cultural structure, which no theory of independent evolution can possibly explain, because chance played so large a part in building it up in its original home.

For instance, it is quite conceivable (though I believe utterly opposed to the evidence at our disposal) that different people might, independently the one of the other, have invented the practises of mummification, building megalithic monuments, circumcision, tattooing and terraced irrigation; evolved the stories of the petrification of human beings, the strange adventures of the dead in the underworld, and the divine origin of kings; and adopted sun-worship.

But why should the people of America and Egypt who built megalithic monuments build them in accordance with very definite plans compounded of Egyptian, Babylonian, Indian and East Asiatic models? And why should the same people who did so also have their wives' chins tattooed, their sons circumcised, their dead mummified? Or why should it be the same people who worshiped the sun and adopted the curiously artificial winged-sun-and-serpent symbolism, who practised terraced irrigation in precisely the same way, who made idols and held similar beliefs regarding them, who had identical stories of the wanderings of the dead in the underworld?

If any theory of evolution of customs and beliefs is adequate to explain the independent origin of each item in the extensive repertoire, either of the New Empire Egyptian or the Pre-Columbian American civilization (which I deny), it is utterly inconceivable that the fortuitous combination of hundreds of utterly incongruous and fantastic elements could possibly have happened twice. It is idle to deny the completeness of the demonstration which the existence of such a civilization in America supplies of the fact that it was derived from the late New Empire Egyptian civilization, modified by Ethiopian, Mediterranean, West Asiatic, Indian, Indonesian, East Asiatic and Polynesian influences.

The complete overthrow of all the objections of a general nature to the recognition of the facts has already been explained. There is nothing to hinder one, therefore, from accepting the obvious significance of the evidence.

Moreover, every link in this chain of connections is admitted by investigators of localized areas along the great migration route, even by those who most strenuously deny the more extensive migrations of culture.

The connections of the New Empire Egypt with the Soudan and with Syria and its relations with Babylonia; the intercourse between the latter and India in the eighth and seventh centuries B.C.; the migrations of culture from India to Indonesia and to the farthest limits of Polynesia—all these are well authenticated and generally admitted.

All that I claim, then, is that the influence of Egypt was handed on from place to place; that the links which all ethnologists recognize as genuine bonds of union can

with equal certainty be joined up into a cultural chain uniting Egypt to America.

In almost every one of the focal points along this great migration route the folk-lore of to-day has preserved legends of the culture-heroes who introduced some one or other of the elements of this peculiarly distinctive civilization.

Those familiar with the literature of ethnology must be acquainted with hundreds of scraps of corroborative evidence testifying to the reality of the spread postulated. For I have mentioned only a small part of the extraordinary cargo of bizarre practises and beliefs with which these ancient mariners (carrying of course their characteristic ideas of naval construction and craftsmanship) set out from the African coast more than twenty-five centuries ago on the great expedition which eventually led their successors some centuries later to the New World.

At every spot where they touched and tarried, whether on the coasts of Asia, the islands of the Pacific or on the continent of America, the new culture took root and flourished in its own distinctive manner, as it was subjected to the influence of the aborigines or to that of later comers of other ideas and traditions; and each place became a fresh focus from which the new knowledge continued to radiate for long ages after the primary inoculation.

The first great cultural wave (or the series of waves of which it was composed) continued to flow for several centuries. It must have begun some time after B.C. 900, because the initial equipment of the great wanderers included practises which were not invented in Egypt until that time. The last of the series of ripples in the great wave set out from India just after the practise of cremation made its appearance there, for at the end of the series the custom of incinerating the dead made its appearance in Indonesia, Polynesia, Mexico and elsewhere.

In asking you to publish this crude sketch of views which I have set forth in greater detail elsewhere[1] I wish especially to appeal to that band of American ethnologists, whose devoted labors in rescuing the information concerning the ethnography of their country have called forth the admiration of all anthropologists, seriously to reconsider the significance of the data they are amassing.

G. ELLIOT SMITH

THE PRODUCTION OF TUNGSTEN

THE tungsten production of the United States during the first six months of 1916 exceed the production of this or any other country in any previous twelve months. Prices were even more phenomenal than production and reached more than ten times their ordinary level. The output was equivalent to about 3,290 short tons of concentrates carrying 60 per cent. WO_3, valued at $9,113,000, according to an estimate made by Frank L. Hess, of the United States Geological Survey, Department of the Interior. Statistics are valuable only so far as their accuracy is known, and this estimate is believed to be correct within 10 per cent. and to be under rather than over the true figures.

These figures are no less noteworthy when it is known that in 1915 much the larger part of the production was in the second half of the year, so that the total domestic output for the twelve months ending June 30, 1916, probably amounted to about 5,000 tons.

Colorado has regained its lead in the production of tungsten ores and, between January 1 and June 30, marketed 1,505 tons, valued at $3,638,000, of which the Boulder field furnished 1,494 tons. California sold 984 tons, valued at $3,005,000. The reason for the higher value of the California ore was that it

[1] "The Significance of the Geographical Distribution of the Practise of Mummification," now being published in the *Memoirs* of the Literary and Philosophical Society of Manchester.

was nearly all sold as high-grade concentrates, but a large part of the Colorado ore sold was of low percentage and had to be milled and concentrated, with consequent expense and loss.

From Nevada 461 tons, valued at $1,432,000, and from Arizona 175 tons, worth $565,000, are estimated to have been shipped. Smaller quantities were mined in Alaska, Connecticut, Idaho, Missouri, New Mexico, South Dakota, Utah and Washington.

Not only were the output and prices unique, but the ratio of the several tungsten minerals produced was different from that of other countries of large production. The quantities and values were approximately as follows: Ferberite, 1,495 tons, $3,590,000; scheelite, 1,404 tons, $4,322,000; wolframite, 201 tons, $613,000; and hübnerite, 185 tons, $587,000.

In most countries the prevailing mineral is wolframite, and no other country approaches the United States in the quantity of ferberite or scheelite produced. The scheelite comes mostly from Atolia, Calif., but significant quantities are mined in Nevada, Arizona, Idaho and Connecticut.

The tremendous increase of prices caused by the need for "high speed" tools to cut war steel ordered by the governments of Europe of course caused the great increase in production. Prices at the beginning of the year were irregular and depended on the buyer's need of the ore and probably on his fear of the possibility of not being able to get it when he might need it even more. Ores carrying 60 per cent. tungsten trioxide brought at that time as much as $66 a unit, but by the last of March some ferberite sold for $93.50 a unit at the mills, and even higher prices were quoted in the newspapers, though they could not be confirmed. The prices of the same ore in the New York market would naturally be somewhat higher. Under the stimulus of these high prices production, not only in this country but in the world at large, has been at the highest point ever known. At first the sudden demand created by the orders for war steel were far ahead of the instant productive power of the country. The rapid increase in prices, starting last fall at a time when tungsten mining was at a low ebb and culminating in the undreamed maximum mentioned, caused prospecting and consequent discoveries of new deposits, increase of development of known deposits, the operating at high tension of old mills, and the hasty building of new mills. As a result, the production increased faster than the consumption and soon overran the demand that would absorb the output at the extremely high prices prevailing, so that a drop in prices was inevitable. June closed with the price around $25 a unit, which was still much higher than any price known before this year. The highest price previously reported to the Geological Survey was $15 a unit, paid in 1907. The normal price has been $6 to $7.

During the six months under consideration 40 mills of various types and sizes were in operation part or all of the time on tungsten ores, and, at the end of June, 14 were under construction.

In the tungsten mining camps the excitement that followed the increase of prices was similar to that caused by important gold discoveries. Nederland, Colo., a little village of two or three dozen homes, suddenly became a town of 3,000 or more inhabitants. East of Nederland two settlements, each containing several hundred people, sprang into existence. Atolia, Calif., a camp of 60 or 80 people, grew to more than a thousand.

SCIENTIFIC NOTES AND NEWS

The Paris Academy of Sciences on June 26 elected as corresponding members Dr. Ramon y Cajal of Madrid to fill the place of M. Perez in the section of anatomy and zoology, and Dr. Morat, professor of physiology at Lyons, to succeed Dr. Zambaco Pasha in the section of medicine and surgery.

Dr. E. Perroncito, professor of bacteriology at the University of Turin, and Professor Kitasato, director of the bacteriologic institute at Tokyo, have been elected foreign members of the Paris Academy of Medicine.

Professor Hugo de Vries, professor of the University of Amsterdam and director of the Botanical Garden, has removed his residence to Lunteren, where he is building a small

private laboratory in connection with an experimental garden. Professor de Vries must by law retire from his professorship at Amsterdam within two years and plans to continue his experimental researches at Lunteren.

A. A. Stevenson, Philadelphia, has been elected president, and S. S. Voorhees, Washington, D. C., vice-president, of the American Society for Testing Materials.

Dr. Alfred E. Cameron, formerly of the department of agricultural entomology, University of Manchester, has taken up duties in the entomological branch, Department of Agriculture, Ottawa, Canada.

Professor R. P. Strong, of the Harvard Medical School, has been visiting the American camps in Mexico to study their sanitary condition.

Dr. Chas. H. Herty, professor of chemistry and dean of the School of Applied Science of the University of North Carolina; Dr. W. R. Whitney, director of the research laboratory of the General Electric Company, Schenectady, N. Y.; Dr. Leo H. Baekeland, of Yonkers, N. Y., and Warren K. Lewis, of Newton, Mass., have been appointed by the American Chemical Society to cooperate with the committee of the National Academy of Sciences on the nitrate supply for the United States government.

The president of Cuba issued a decree on July 3, creating a plant quarantine and inspection service under the name Comisión de Sanidad Vegetal. The commission is composed of John R. Johnston, pathologist of the Estacion Experimental Agronomica as president; Mario Sanchez Roig, professor of natural history in the Agricultural School of Havana, as secretary, and Patricio Cardin, entomologist of the Estacion Experimental Agronomica. Three field inspectors have been appointed, one to attempt control of the spiny white fly of citrus, one to begin the "sanitation" of the coconut groves on account of the budrot, and the third to clean up the banana plantations affected by the Panama disease. In addition to the attempt at control of these most serious plagues, the commission will also have in charge the arrangements for quarantine regulations affecting the importations and exportations of plants.

At the conference on infantile paralysis held last week in New York, Dr. Simon Flexner, director of the laboratories of the Rockefeller Institute, was elected to preside, and two committees were appointed. One, which is to study laboratory methods, is made up of Dr. Ludwig Hektoen of the University of Chicago, Dr. Hans Zinsser, professor of bacteriology in the College of Physicians and Surgeons; Dr. Richard M. Pearce, Jr., professor of research medicine in the University of Pennsylvania; Dr. J. W. Jobling of Vanderbilt University, Dr. G. W. McCoy of the Government Hygienic Laboratories in Washington, and Dr. Theobald Smith of the Rockefeller Institute. The members of the second committee, which is to study methods of prevention, are Dr. Victor C. Vaughan of the University of Michigan, Dr. M. J. Rosenau of Harvard, Dr. William H. Park of the New York Health Department Laboratories, Dr. Francis W. Peabody of the Peter Brent Brigham Hospital in Boston, Dr. John Howland of Johns Hopkins University, Dr. Augustus Wadsworth of the State Health Department, and Dr. Charles C. Bass of Tulane University, New Orleans.

The British prime minister has appointed, as we learn from *Nature*, a committee to consider the commercial and industrial policy to be adopted after the war, with special reference to the conclusions reached at the economic conference of the allies, and to the following questions: (*a*) What industries are essential to the future safety of the nation; and what steps should be taken to maintain or establish them. (*b*) What steps should be taken to recover home and foreign trade lost during the war, and to secure new markets. (*c*) To what extent and by what means the resources of the Empire should and can be developed. (*d*) To what extent and by what means the sources of supply within the Empire can be prevented from falling under foreign control. The committee is composed as follows: Lord Balfour of Burleigh (chairman), Mr. Arthur Balfour, Mr. H. Gosling, Mr. W. A. S. Hewins, M.P., Mr. A. H. Illingworth, M.P., Sir J. P. Maclay,

Sir A. Mond, M.P., Mr. Arthur Pease, Mr. R. E. Prothero, M.P., Sir Frederick H. Smith, Mr. G. J. Wardle, M.P., together with the following gentlemen, who are presiding over the Board of Trade committees on the position of important industries after the war: Sir H. Birchenough, Lord Faringdon, Sir C. G. Hyde, Sir C. A. Parsons, F.R.S., Lord Rhondda and Mr. G. Scoby-Smith. Mr. Percy Ashley, of the Board of Trade, and Mr. G. C. Upcott, of the Treasury, have been appointed secretaries to the committee.

The trustees of the Beit fellowships for scientific research, which were founded and endowed three years ago by Mr. Otto Beit, in order to promote the advancement of science by means of research, have elected to fellowships for 1916–17: Mr. H. N. Walsh, Cork (extension for a second year); Mr. W. A. Haward, Tufnell Park, and Mr. C. C. Smith, Bristol. The three fellows will carry on their researches in the Imperial College of Science and Technology, London.

Messrs. A. J. Grove and L. Harrison have been appointed by the British War Office to advise on entomological problems in connection with the military operations in Mesopotamia. The services of Dr. W. A. Lamborn have been lent by the Imperial Bureau of Entomology to the War Office and he is now attached to the expeditionary force in East Africa.

According to a cablegram from England Lieutenant Sir Ernest Shackleton has again failed to rescue the main body of his Antarctic expedition left on Elephant Island and has returned to the Falkland Islands. Sir Ernest returned on board the steamer *Emma* from Port Stanley. The ship was forced back by heavy gales and ice and it was found impossible to get near Elephant Island through the pack ice. The ship was battered, the engines were injured and the *Emma* was obliged to proceed under sail. Sir Ernest, the correspondent adds, recognizes that it is useless to attempt to force a passage with a light ship and he is waiting for the steamer *Discovery* to come from England.

Professor Samuel Wendell Williston, of the department of geology and paleontology of the University of Chicago, has given four lectures on the afternoons of August 1 to 4 inclusive, the subjects of the separate lectures being: "The Earliest Land Animals—Amphibians," "The Earliest Land Animals—Reptiles," "The Evolution of Reptiles" and "The Evolution of Mammals."

The death, at the age of fifty-three years, is announced of Elton Fulmer, professor of chemistry and dean of the faculty in the Washington State College at Pullman.

Frederick William Frankland, associate actuary for the Equitable Life Assurance Society, died on July 26 at his home in New York City. He was a son of the late Sir Edward Frankland, and was born in Manchester, England, sixty-three years ago. Mr. Frankland came to this country nine years ago, and was for some years connected with the New York Life Insurance Company. He had written many papers on mathematical, metaphysical and sociological subjects.

Dr. Rowland Cox, Jr., of Paterson, N. J., who was for seven years instructor in operative surgery in the College of Physicians and Surgeons, Columbia University, has died in his forty-fifth year.

The death is announced of Ludwig Siegmund Albert Neisser, professor of skin and venereal diseases at the University of Breslau, one of the distinguished German pathologists. He was born sixty-one years ago at Breslau, where his father was a physician, who translated several American works into German, including G. M. Beard's "Neurasthenia."

The secretary of war has submitted a supplemental estimate of appropriation of $7,000,000 required for the service of the fiscal year, 1917, by the medical and hospital department for the medical needs of an active military force of 400,000 men, in addition to amounts heretofore estimated for such purpose.

Announcement is made that the Psychopathic Clinic for Mentally Deranged and Feebleminded Persons at the State Prison,

Sing Sing, has received an endowment of $10,000 from John D. Rockefeller. The clinic was opened on August 3, and the advisory board is composed of Drs. Terry M. Townsend, George S. Burns and William Seaman Bainbridge.

The *Journal* of the American Medical Association notes that an anonymous donor has offered a prize of $10,000 to be handed over to the maker of the mechanical apparatus best supplying the place of the hand. All competitors must belong to allied or neutral nations. They are to demonstrate before the French Surgical Association mutilated men who have been using their apparatus for at least six months. The surgical association will experiment with each apparatus on mutilated men for the length of time it thinks fit. The apparatus rewarded is to remain the property of its inventor. The competition will be closed two years after the end of the war. Any person wishing to compete should write M. le Secrétaire Général de la Société Nationale de Chirurgie, 12, rue de Seine, Paris, France.

The Mary Murdoch Memorial Loan Fund has been raised to perpetuate the memory of Dr. Mary Murdoch, of Hull, her high professional standard and the inspiration and encouragement she was to her colleagues and friends. The committee which has been formed to administer the fund is prepared to grant loans of £100 or less, free of interest, so as to give women doctors some financial help at a time when they may specially need it. Such special need might be during their early years of establishment in practise, to enable them to study some special subject or purchase some particular apparatus, etc. This fund will be open to all medical women, but preference will be given to those who have been trained at the London School of Medicine for Women, which was Dr. Murdoch's school.

Presenting a report on the year's work at Commemoration Day at King's College, the principal, Dr. Burrows, said that regular men students of English birth had fallen from over 800 in the year previous to the war to a little over 100. The college had contributed 512 officers to the army and navy. Fifty-seven students had lost their lives. Twenty-one members of the staff were on war or munition service, three of whom held the rank of lieutenant-colonel. On the science side every laboratory in the college was being worked in the service of the government. Professor Jackson, in the chemistry department, had solved the formulæ for making all the delicate kinds of glass, including miners' safety lamps, which had hitherto been made in Germany and Austria. Professor Bottomley was still engaged on his researches on bacterized peat, which, it was hoped, would effect a revolution in the treatment of poor soil. The department of engineering had devoted itself to the training of unskilled labor for munition factories.

The Hawaii National Park, just created by Congress, is the first national park lying outside the continental boundaries of the United States. It sets the three Hawaiian volcanoes, Kilauea, Mauna Loa and Haleakala, and entrusts their protection and development to the Department of the Interior. "The Hawaiian volcanoes," writes T. A. Jaggar, director of the Hawaiian Volcano Observatory, "are truly a national asset, wholly unique of their kind, the most famous in the world of science and the most continuously, variously and harmlessly active volcanoes on earth. Kilauea crater has been nearly continuously active with a lake or lakes of molten lava for a century; Mauna Loa is the largest active volcano and mountain mass in the world, with eruptions about once a decade, and has poured out more lava during the last century than any other volcano on the globe. Haleakala is a mountain mass 10,000 feet high, with a tremendous crater rift in its summit eight miles in diameter and 3,000 feet deep, with many high lava cones built up inside the crater. It is probably the largest of all known craters among volcanoes that are technically known as active. Haleakala erupted less than 200 years ago. The crater at sunrise is the grandest volcanic spectacle on earth."

Van H. Manning, director of the Bureau of Mines of the Department of the Interior, will

visit the University of Washington in the near future to determine whether it shall have the mining experiment station to be established in the northwest. Congress recently authorized the establishment of ten of these stations. One has already been established at Fairbanks, Alaska, and another is to be located in one of the North Pacific states. The University of Washington has asked that this station be located here. It is pointed out that Seattle is ideally located for the North Pacific station, and that the university with its school of mines, is well equipped to do the scientific research and experimental work that will be required. While the University of Washington's request for the station has the endorsement of the senators and representatives it is meeting with some opposition. The University of Idaho, at Moscow, is also anxious to obtain the station, and the Montana delegation in congress favors Idaho. The chief work of the stations will be to find ways and means for the profitable handling of low grade ore. Each station will be given $25,000 annually by the federal government for the establishment and maintenance of the station.

Some time ago the British government appointed a committee of the privy council for scientific and industrial research, so as to coordinate science with industrial work. When the White paper elaborating the proposed researches of the committee reached Mr. Hagelthorn, then minister for public works of the Australian Commonwealth, he suggested that the operations of the committee should be imperial in scope, and not limited to Great Britain. With this view the prime minister (Mr. Hughes) agreed, and at once constituted a Science Congress, which has had several meetings, and has submitted a report to the Commonwealth government. The suggestion of Mr. Hagelthorn was brought under the notice of the Secretary of State for the colonies, and a reply has been received agreeing that the committee of the privy council should be given a wider scope, and it will therefore include the empire on all questions that extend beyond the boundaries of Great Britain or the special dominions. Mr. Hughes has been in consultation with the committee of the privy council since he has been in London, and on his return the work of the Science Congress in Australia will be coordinated with that of the committee of the privy council.

In the forty-seventh annual report of the American Museum of Natural History, President Henry Fairfield Osborn lays stress upon the urgent need of the institution for more space. No building has been added since the erection of the southwest wing under the law of 1905, while the collections have doubled in extent, important educational departments have been opened, available space in the present building is crowded to capacity, and the scientific and educational value of some of the finest collections in the world is lost for lack of a building in which to house them. The estimated cost of the proposed new southeast wing and court building is $750,000. It will provide space for the collections of mammals of the sea and fauna of Europe and Asia; for the splendid collections of existing fishes and reptiles, now crowded away in the dark and out of sight; for the superb collection of whales hitherto not exhibited; for other collections, and for offices, laboratories and storage room which are seriously needed. Since it seems possible that the finances of New York City will not permit of the building of this extension in the near future, the question is being considered by the trustees of the museum as to the advisability of raising funds for the new wing by private subscription and solving in this way a problem that is rapidly reaching a crisis.

The medical committee of the British Science Guild, under the chairmanship of Sir Ronald Ross, passed, as we learn from *Nature*, the following resolutions at a recent meeting: (1) The medical committee of the British Science Guild views with disfavor the suggestion that has been made by certain district councils to cease watering the streets as a war economy, and is convinced that such a step would be prejudicial to the public health. (2) The medical committee also views with great disfavor the pollution of the streets of London, and of most cities and big towns, by dogs, and

considers that the attention of the government and of municipalities should be called to the possibility of reducing the evil by increasing the tax on dogs and by enforcing bylaws. The committee considers that in towns the tax on one dog should be doubled and a large progressive increase imposed on each additional dog.

THE Henry S. Upson Foundation has been organized in Philadelphia for the purpose of encouraging the systematic study of problems wherein dental pathologic conditions are correlated with those of internal medicine, surgery, neurology and psychiatry. The late Henry S. Upson, professor of neurology in the Western Reserve University, had been for years deeply interested in the subject, and the foundation has been endowed by Mrs. Upson as a memorial to her husband. The organization is composed of a commission, the members consisting of Drs. Edward C. Kirk, chairman, J. Madison Taylor, Charles E. deM. Sajous, Nathaniel Gildersleeve, Hermann Prinz and Arthur Hopewell-Smith. This commission elected an executive committee consisting of three members of the commission—namely, Dr. Edward C. Kirk, chairman, Dr. J. Madison Taylor, secretary, and Dr. Nathaniel Gildersleeve. This committee selected a board of associate experts in lines which include the more cognate subjects, consisting of Dr. De Forrest P. Willard, orthopedist; Dr. Wendell Reber, ophthalmologist; Dr. Morris Piersol, internist; Dr. Charles R. Turner, prosthetist; Dr. M. H. Cryer, oral surgeon; Dr. John V. Mershon, orthodontist; Dr. S. D. W. Ludlum, neurologist; Dr. Ralph Butler, rhinologist and laryngologist, and Dr. Edward Schuman, pediatrist.

UNIVERSITY AND EDUCATIONAL NEWS

THE vocational-educational bill, providing for federal cooperation with the states in promoting agricultural and industrial education, makes an annual appropriation beginning at $500,000 and increasing each year by $250,000 until $3,000,000 is reached, to be apportioned to the states in proportion to their rural population.

THE trustees of the University of Indiana have recommended that a new medical school building, power house, laundry and nurses' home be erected on the grounds of the Robert W. Long Hospital, Indianapolis. A committee was appointed, including the president of the university, Drs. Samuel Smith, Richmond; Charles P. Emerson, John H. Oliver and Frank F. Hutchins, Indianapolis, to formulate plans for the proposed building and report to the board.

LORD CREWE at a meeting of the governing body of the Imperial College of Science and Technology, speaking, on June 30, of the professor's memorial on the neglected teaching of science, said that the government intended to appoint a committee of scientific men to inquire into the position of natural science in the English educational system, especially in the universities and secondary schools.

DISCUSSION AND CORRESPONDENCE

MOSQUITOES AND MAN

IN SCIENCE for June 2, 1916, p. 784, Dr. C. S. Ludlow calls attention to the association with man of those species of mosquitoes concerned in disease transmission, laying particular stress upon *Anopheles* and malaria. This is an important factor in epidemiology all too frequently overlooked by the sanitarian, but it is surprising to find that Dr. Ludlow claims for Major P. M. Ashburn, as indeed he does for himself, the discovery of this relation.

The fact is, this relationship has been long recognized by careful students. Its consideration unquestionably led Finlay to his deduction as to the transmission of yellow fever, the truth of which was afterward so thoroughly demonstrated by the American Army Commission.

In the case of malaria, Grassi was led to the discovery of the Anopheline host by similar considerations. He attacked the problem from the ecological viewpoint, eliminating those blood-sucking forms which did not coincide with the disease in distribution. This is really only a different formulation of the same idea.

India has probably produced a larger num-

ber of careful investigators of malaria and *Anopheles* than any other region. The fact that certain species of *Anopheles* occurred only in proximity to man, while others were "wild" was appreciated as early as 1902 and 1903 and it is set forth in the classic "Monograph of the *Anopheles* mosquitoes of India," by James and Liston (1904). A single brief quotation from Stephens and Christophers will be sufficient to demonstrate this.

Anopheles rossii was found by us always near human dwellings, and often in very foul water. In spite of this commonness of the species, larvæ were never found more than a stone's throw from dwellings. If in any place larvæ were discovered at a greater distance, they invariably turned out to be the larvæ of other species. *A. rossii* appears, then, in Bengal to be "foveal" in its distribution, in contradistinction to other species of *Anopheles* to be described.[1]

This difference in habits of the different species of *Anopheles* is generally recognized among workers in India, and one finds frequent allusions to it in their writings.

In Africa, a similar tendency on the part of certain species of *Anopheles* to associate with man has been noted and a number of authors could be cited in demonstration.

In America, the interrelation, at least in connection with malaria, seems to have been recognized rather tardily. Knab enunciated and discussed it in a series of papers published during 1912 and 1913 (1, 2, 3, 4, 5).

His deductions were based, he asserts, upon observations made by the writer in the Panama Canal Zone. The adaptation was indicated very clearly in discussing *Anopheles albimanus*, precisely the species, it is interesting to note, which also impressed Major Ashburn. I quote from the original statement.

While not domestic in the same sense as *Stegomyia calopus*, *Anopheles albimanus* is closely associated with man and finds its most congenial surroundings about his habitations and in the conditions he creates in the course of agricultural, engineering and other work. This fact is correlated with the highly developed blood-sucking habit and has been an active factor in its development and in establishing the economic importance of the species (6).

[1] Reports to the Malaria Committee of the Royal Society, London, 6th Series, p. 15, 1902.

The same relation of *Anopheles albimanus* toward man was observed by another worker in the Panama Canal Zone, James Zetek, and discussed in a paper published in 1915.

Quoting briefly:

The writer in his inspection of the Canal Zone, found *A. albimanus* to breed only near settlements. It therefore seems quite plausible to believe that the pathogenic species of *Anopheles* become more and more restricted to human settlements, an adaptation which no doubt will hold for all animals which play a rôle similar to that of *albimanus* in the transmission of disease (10).

But too sweeping claims regarding the adaptation of the malaria-transmitting *Anopheles* should not be made. The writer, as quoted above, has already indicated that the association with man is a much looser one than in the case of *Ædes calopus*, and, it should be added, *Culex quinquefasciatus* (*fatigans*). Knab points out that the long period during which the malarial gametes are present in the human circulation effectively compensates for less frequent opportunity for infection of the mosquito. Dr. Adolph Lutz of Brazil even goes so far as to condemn altogether the idea of adaptation in the case of *Anopheles* (7, 8).

He asserts that in Brazil, *Anopheles albimanus* occurs in uninhabited localities. Nor will he admit any predilection for man on the part of this mosquito, since he has observed that it prefers the horse to the rider (l. c.). In fact, no such predilection has been demonstrated for any *Anopheles*, except, perhaps, it can be inferred in the case of the Indian *Anopheles rossii*. That it does not exist in the European *Anopheles maculipennis*, which unquestionably has had all possible opportunity to develop such a taste, has been very clearly shown by Mühlens (9). Grassi and others have gone on record that the degree of attraction depends upon the size of the animal, a man being preferred to a dog, a horse or cow to a man.

This much must be admitted in any case; that the highly developed appetite for blood of certain species of *Anopheles* and frequent op-

portunities to satisfy that appetite from the same host, man, has made the malarial relation possible.

The important malaria transmitters are to be found among the most bloodthirsty species, and such species will mutiply rapidly in the presence of an abundant food-supply, as when laborers are massed at some previously uninhabited point. That there will be a corresponding decrease in these *Anopheles* when the food-supply is removed goes without saying.

Returning to the conditions in India, it is interesting to note that the most "domestic" species of *Anopheles rossii,* already indicated in the foregoing, is not a malaria transmitter. The most important transmitters are species normally breeding at a distance from human habitations and showing no special "domesticity." They have, however, a very highly developed appetite for blood, and this, in spite of their very much smaller numbers, makes them most effective transmitters of the malarial parasites.

1. (1912, April 27.) Knab, F., Unconsidered Factors in Disease Transmission by Blood-sucking Insects. *Jour. Econ. Ent.*, Vol. 5, pp. 196–200.
2. (1912.) Knab, F., [Dependence of Disease Transmission by Blood-sucking Insects upon Habits]. *Proc. Ent. Wash.*, Vol. 14, pp. 79–81.
3. (1913, Jan. 13.) Knab, F., Blood-sucking Insects as Transmitters of Human Disease. *Proc. Ent. Soc. Wash.*, Vol. 14, pp. 219–221.
4. (1913, July.) Knab, F., The Species of *Anopheles* that Transmit Human Malaria. *Amer. Jour. Trop. Dis. and Prev. Med.*, Vol. 1, pp. 33–43, 277.
5. (1913, Oct. 3.) Knab, F., The Contentions regarding "Forest Malaria." *Proc. Ent. Wash.*, Vol. 15, pp. 110–114.
6. (1912.) Jennings, Allan H., Some Problems of Mosquito Control in the Tropics. *Jour. Econ. Ent.*, Vol. 5, pp. 131–141.
7. (1913.) Lutz, A., The Insect Host of Forest Malaria. *Proc. Ent. Soc. Wash.*, Vol. 15, pp. 108–109.
8. (1913.) Lutz, A., Forest Malaria. *Proc. Ent. Wash.*, Vol. 15, pp. 169–170.
9. (1908.) Mühlens, P., Ueber einheimische Malariaerkrankungen in der Umgegend von Wilhelmshaven und ihre Bekämpfung. *Arch. f. Schiffs- u. Tropen-Hyg.*, Bd. 5, pp. 58–70; Malariabekämpfung in Wilhelmshaven und Umgegend. ii. *Arch. f. Schiffs- u. Tropen-Hyg.*, 1909, Beiheft 6, pp. 166–173.
10. (1915.) Zetek, James, Behavior of *Anopheles albimanus* Wied. and *tarsimaculata* Goeldi. *Ann. Ent. Soc. Amer.*, Vol. 3, pp. 221–271.

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GOITER AMONG THE INDIANS ALONG THE MISSOURI

THE writer would like to call the attention of those interested to the excessive prevalence of goiter and symptoms of thyroid derangement among the Indians along that part of the Missouri Valley comprised between the Cannon Ball Creek and Cheyenne River, in North and South Dakota. The prevalence and relative acuteness of these conditions are such as to demand some special steps for their control or relief, and invite a thorough local investigation of conditions by specialists or institutions.

The people in question are the Cheyenne River and Fort Yates Sioux, and were visited by the writer last April. The frequency of goiter among the Cheyenne River bands ("Blackfeet" and "Two-Kettle") has been known for many years. In 1908, on the occasion of the writer's report on various diseases among the Indians,[1] they were in that respect at the head of the column, with 61.4 cases of goiter per thousand population, compared to 3 per thousand for the U. S. Indians as a whole. But the present extent and the equally great or even greater frequency of the disease in certain parts of the Fort Yates territory have not been suspected.

The writer examined in the two localities mentioned between 400 and 500 children and adults. The examinations were for anthropological purposes, and no record was kept of the exact proportion of thyroid enlargements; but the subject soon forced itself upon his attention. Case after case was met, particularly

[1] Hrdlička, Aleš, "Physical and Medical Observations among the Indians of Southwestern U. S. and Northern Mexico," p. 201.

among the adults, in which the pulse was excited, the heart enlarged and the temperature slightly above normal. There were over 30 per cent. of such cases among the younger and middle-aged adults among the Cheyenne River Sioux, and about the same proportion at Fort Yates, particularly in the vicinity of the Farm School. At first the symptoms were puzzling and attributed to rheumatism, excessive use of coffee, or tobacco; but it was soon seen that in most if not all cases they were connected with a greater or lesser thyroid enlargement, and eventually it became plain that they were due to the latter and were the symptoms of thyroid derangement.

The foremost question in this connection is, what are the causes of this localized prevalence of serious disturbances of the thyroid gland. It is not a tribal peculiarity, for other branches of the Sioux away from the river are less affected. There is no evidence that the disease extends for any great distance along the Missouri, or is common among the whites of same localities. The water used by the natives is mostly that of the Missouri and its small affluents. The present habits of these Indians are those of fairly civilized Indians in general. They were always hunters and great meat eaters, and are doubtless still more so than agricultural tribes, but this is true of all the Sioux. The country is of the rolling prairie type, the climate rigorous but not over-severe. Malarial infections are infrequent, but scrofula, consumption and venereal diseases prevail; all of which affords no clue as to the causes of the goiter.

It seems that here, if anywhere, in this country there is a good chance for a thorough investigation, by modern means, of the conditions leading to thyroid enlargement. The people concerned are very tractable, and both reservations are within easy reach of the railroad. The Bureau of Indian Affairs would doubtless favor and assist the investigations. In his visits to upwards of 50 tribes the writer has never met with a locality where the thyroid "infection" was as prevalent and active, and where conditions for research into its causes

In conclusion it may be added that goiter among Indians is not, so far as the writer's experience goes, connected with cretinism, which seems not to occur at all in that race, or with myxedema, and only rarely and moderately with exopthalmy.

Aleš Hrdlička

U. S. National Museum

COMPULSORY MATHEMATICS—AN EXPLANATION

To the Editor of Science: Professor Keyser, in reviewing Professor Miller's "Historical Introduction to Mathematical Literature"[1] speaks of "the nation-wide depreciatory utterances of such educational leaders and agitators as Commissioner Snedden and Abraham Flexner" (relative to the value of the study of mathematics, I infer). I think he can not be fully informed as to my position.

My objection is merely against giving high-school mathematics a highly "protected" position, shared by no other subject except English, as we do now through college entrance requirements and the traditions controlling in secondary schools. I know (having been a moderately successful teacher of high-school mathematics myself for several years) that a substantial percentage of high-school pupils, otherwise of good ability and promise, do not respond well to mathematic teaching, and, I believe, do not materially profit from the assigned tasks, which are uninteresting, discouraging, and even, at times, obnoxious, to them. I think this is frequently the case with pupils of literary bent and artistic leanings.

I naturally very much favor the extended study (preferably under better teaching than we now obtain from the teachers prepared by our college departments of mathematics) of secondary school mathematics by all those anticipating vocational studies or pursuits where the results of such study serve a demonstrably instrumental purpose. Furthermore, I should strongly encourage other pupils to undertake these studies and to pursue them vigorously as long as they can be made to find the drill and the broadening outlook given by them interesting and, probably, fruitful.

[1] Science for July 7, 1916, pp. 25–28.

But I do not attach much weight to the pedagogical principle, succinctly stated by Dooley that "It doesn't matter what you teach a boy, so long as he doesn't like it." To give point to my attitude, I have frequently asked the question "Why should a girl be required to 'pass' in mathematics as a condition of entering an American college and (usually) of graduating from an American high school?" Is algebra, as usually taught, a subject of such unique educational excellence in general education, and does it in so exceptional a measure train the mind or give rise to the appreciations and insights which we call culture, that it should have the monopolistic position in our secondary schools which we now give it? To me this is an important question; and in asking it, I have no intention of depreciating the values, demonstrable or assumed, which that subject may still possess for a large proportion of the one million three hundred thousand pupils now found in our public high schools.

David Snedden

Columbia University,
July 18, 1916

THE SOUTHERN BULLFROG, RANA GRYLIO STEJNEGER

The southern bullfrog was first pronounced a distinct species by Dr. Leonhard Stejneger of the U. S. National Museum in 1902.[1] Miss Dickerson in "The Frog Book" (1906) describes and gives photographs of this southern frog. It has been reported only from Pensacola, Kissimmee and Ozona, in Florida, and from Bay St. Louis, in Mississippi. It is evident that little is known concerning the limits of the range of this frog.

Although the frog was first obtained at Bay St. Louis, Mississippi, it appears to have been known to some of the older naturalists more than a century ago. It is interesting to note that William Bartram appears to have been well acquainted with this frog and considered it distinct from the common bullfrog, *Rana catesbiana*. This excellent naturalist, on page 272 of his book, "Travels through North and South Carolina, Georgia, East and West Florida" (1792), says:

> The largest frog known in Florida and on the seacoast of Carolina is about eight or nine inches in length from the nose to the extremity of the toes; they are of a dusky brown or black color on the upper side, and their belly or underside is white, spotted and clouded with dusky spots of various size and figure; their legs and thighs also are variegated with dark brown or black; and they are yellow and green about their mouth and lips. They live in wet swamps, on the shores of large rivers and lakes; their voice is loud and hideous, greatly resembling the grunting of swine; but not near as loud as the voice of the bullfrog from Virginia and Pennsylvania: neither do they arrive to half the size, the bullfrog being frequently 18 inches in length and their roaring as loud as that of a bull.

From Bartram's description of the color and markings, one can not say with certainty that he did not confuse the southern bullfrog to some extent with the common bullfrog, which is also known to extend its range into Florida. However, his description of the voice makes it certain that he had heard the frog *Rana Grylio* as named by Stejneger.

H. A. Allard

Washington, D. C.,
April, 1916.

[1] "A New Species of Bullfrog from Florida and the Gulf Coast," *Proc. Nat. Museum U. S.*, Vol. 24, pp. 211–215, 1902.

SCIENTIFIC BOOKS

Outlines of Industrial Chemistry. By Frank Hall Thorp, Ph.D., with assistance in revision from Warren K. Lewis, Ph.D., professor of chemical engineering in the Massachusetts Institute of Technology. Third revised and enlarged edition. Published by the Macmillan Co., New York. Cloth. 8vo. Pp. 665. Price $3.75.

As the second edition of this well-known text-book appeared in 1905, a material revision of its pages was found necessary and many sections have in consequence been altogether rewritten with elimination of obsolete matter and introduction of new material.

One of the problems which must necessarily present itself to the writer of a one-volume text-book on so extensive a subject as industrial chemistry is to know how to choose the

fundamental facts needed to enable the student to get a properly proportioned picture of an important individual industry. Too much detail can not be indulged in or the book soon becomes encyclopedic and the relationship and interdependence of related industries is lost sight of. German text-books on chemical technology, like Wagner's well-known work, become ultimately too bulky to be available as text-books, and of quite a number published in that language there is at present only one that may be called sufficiently inclusive and yet remains compacted into one volume of modern size, viz., Ost's "Chemische Technologie," which has in consequence run quite rapidly through many editions.

Professor Thorp planned at first to omit metallurgy because it was generally treated separately in special text-books, but he has reconsidered this, and Part III. of the present edition is devoted to metallurgy. He has sought to economize space by leaving the chemistry of coal-tar colors out of special consideration, although a classification of them according to the conditions of their application in dyeing processes has been found necessary. With the awakening interest in the establishment of an American dye-color industry, it will probably be found desirable to take up the chemistry of coal-tar intermediates and ultimate color products for all advanced chemical students. When congressmen and the daily newspapers begin to discuss the merits of our new dye-color tariff, the graduates of our technical schools must be ready to talk intelligently on the subject.

The new edition of Professor Thorp's book covers, however, a great range of important subjects and covers them well, presenting the outlines of processes clearly and making the subject interesting to the reader or student.

As an illustration we would note the article on Glass Manufacture on pp. 196 et seq. The presentation shows the clearness of view acquired by the teacher who has learned clarity of expression by the experience of the classroom. The same may be said of the section on Pigments, p. 222, which is excellent in form and substance. If we may be allowed to criticize the treatment of some of the sections, we would say that the asphalt section is hardly adequate in its handling of either the chemistry or the technology of this important subject, and the present view of asphalt as polymerized petroleums rather than oxidation products is not mentioned.

Similarly under the Match Industry we find no mention of the use of P_4S_3, phosphorus sesquisulphide, in the manufacture of the "strike-anywhere" matches which have come in with the legislation against the use of white phosphorus for match compositions.

The modern theories with regard to colloids are noted and in several sections, the phraseology of modern colloid chemistry has been applied to explain fundamental phenomena. We can not be sure that the understanding of these processes has always been improved by this unreserved application of colloid theories, as, for example in the explanation of leather manufacture on p. 573.

The book, however, as before said, is generally up to date and clearly written, with a uniformity of method of presentation which makes it much better for a text-book than works made up of contributed articles of varying degrees of value from a number of writers.

S. P. Sadtler

Urgeschichte der bildenden Kunst in Europa von den Anfängen bis um 500 vor Chr. Von M. Hoernes. Zweite durchaus umgearbeitete und neu illustrierte Auflage mit 1330 Abbildungen im Text. Mit Unterstützung der Kais. Akademie der Wissenschaften in Wien. Wien 1915. Kunstverlag Anton Schroll & Co., Ges. M. B. H. Pp. xiv + 661.

The period elapsing since 1898, when the first edition of this important work appeared, has been one of marked progress in our knowledge of prehistoric art. The author, being able to take full advantage of the opportunity, has made of the new edition practically a new work.

The first part deals with primitive art in general. Geometric art is found to be neither older or younger than realistic art. One can say however that it is the more common, the

easier; in fact among some races it is the only art, and hence among such presumably the older. In other cases it plays a secondary rôle. In Europe at least it appeared only after a long and brilliant period of naturalism. The realistic art of the Cave period may be looked upon as the art of the male, and that of the neolithic period as that of the female; in other words sex is supposed to be at the basis of the differences between realism and conventionalism. The making of basketry and pottery was the work of woman, and their ornamentation, the product of her mind. In this cleavage religion, or the absence of it, might also have had something to do; for the tendency of religious art is toward the conventional, while that of profane art is toward the natural. Thus in the opinion of the author idols were unknown until the neolithic age.

Our conception of prehistoric art is of necessity based on partial evidence only. We can know nothing of the then existing dance, music and poesy; and very little of art as expressed in personal adornment.

It is justly pointed out that the differentiation between the historic and the prehistoric does not consist in a knowledge of any particular one of the three principal metals of antiquity; for in the Orient the historic period long antedates the closing of the bronze age, whereas the historic period in Europe begins during the iron age. Differences equally marked are to be noted elsewhere. The negroes of Africa, for example, with their knowledge of iron, have not yet reached so high a stage of culture as did the prehistoric peoples of Central and South America, among whom the use of iron was absolutely unknown.

The three great culture stages in Europe—the paleolithic, the neolithic, and the age of metals—correspond to three great phases of art: *Jägertum, Bauerntum,* and *Herren-* or *Kriegertum.* The art of the hunter stage lasted longest and reached its highest development in western Europe, especially southern France and northern Spain; that of the peasant stage took deepest root in central and northern Europe; while the martial stage first came to fruition in southern Europe. The art of the first stage was naturalistic, of the second geometric, and of the third a return to a higher realism under the control of conventionalism.

The author takes issue with Breuil respecting the age of the wall paintings of southern and southeastern Spain. From the viewpoint of art these certainly differ from the paleolithic mural art of the Cantabrian region. It is probable therefore that they belong to a later epoch, even later than the Azilian, although many of the designs on the painted pebbles of Mas d'Azil have their counterparts in the mural art of southern Spain as recently noted by Obermaier.

For Hoernes the Cave art of southern France and northern Spain is a highly specialized type, a peripheral culture phenomenon. Hence from it the art of the succeeding epochs did not and could not spring, because of a well-known law in evolution that highly specialized types of one geologic horizon do not give rise to the types of subsequent epochs.

In the field of ceramic art Hoernes distinguishes two fundamental methods of ornamental treatment: the *Umlaufstil* and the *Rahmenstil.* The first with its space-filling banded ornament is supposed to be the older, although neither is wholly confined to the neolithic period. The second with its panel ornamentation goes logically with the various forms of handled ware. The banded style, on the other hand, is expressive of ware without handles; to it belong the spiral and meander decoration.

During the bronze age the best examples of decorative art are to be seen in metal work; this is especially true of northern Europe. It was during this age that plant motives first appeared.

The passage from the bronze age to the iron age took place slowly, at first in the Orient and in Egypt; in Greece about 1200, in Italy 1100, and in central Europe about B.C. 1000. In the ceramic field the Hallstatt epoch is not so much an outgrowth from the bronze age as from the neolithic age. The banded as well as the panel style of the Hallstatt epoch is foreshadowed in the neolithic pottery of

east central Europe. The Dipylon and the Villanova style representing the earliest phase of the iron age in Greece and Italy, respectively, both abound in banded and panel patterns, especially the meander and the swastika. (The swastika is supposed to date as far back as the neolithic period.)

The art of the smith made rapid strides during the Hallstatt epoch. A process was developed of at least superficially hardening a blade of iron, although steel proper was as yet unknown. The engraved ornaments of the bronze age now give place largely to embossed patterns produced by hammering. With the epoch of La Tène the art of the third and last great stage (Kriegertum) spread over western and northern Europe.

The revision is everywhere both conservative and thorough; some thirty pages of addenda and references will contribute much toward its usefulness as a source book.

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THE MECHANISM OF LIGHT PRODUCTION IN ANIMALS

It has long been known that the dried powdered luminous organs of the fire-fly will glow if moistened with water containing oxygen. No light is given off if oxygen is absent. In a previous issue of Science I pointed out that if we allow this dried powder to stand for an hour in contact with water carefully freed of its dissolved oxygen and then admit oxygen, no phosphorescence is to be observed. It is quite obvious that the photogenic substance has been changed in some way even though no oxidation has taken place. The substance, therefore, which in presence of oxygen is oxidized with the production of light, in absence of oxygen is also decomposed but without light production. We have an analogous instance in the compound lophin (triphenylglyoxaline) investigated by Radziszewski. If hydrolyzed in presence of oxygen by alcoholic potassium hydrate, light is produced and benzoic acid and ammonia formed. In absence of oxygen, no light is produced and benzaldehyde is formed instead of benzoic acid. The alkali acts as a catalyzer.

In the fire-fly it is natural to suppose that an organic catalyzer, an enzyme, is concerned in light production and it is the purpose of this paper to point out the fact that the existence of such an enzyme has been definitely proved and to add certain new facts to our knowledge of bioluminescence. The credit of this discovery belongs entirely to Professor Raphael Dubois, of the University of Lyons. As early as 1884 Dubois made the crucial experiments in which he showed that two substances are present in the luminous organs of *Pyrophorus noctilucus*, the West Indian cucullo, a thermostabile substance, luciferin, which oxidizes with light production and a thermolabile enzyme luciferase. In 1887 Dubois showed that the same was true for the luminous mollusc, *Pholas dactylus*. If the luminous slime from glands on the siphon and mantle of this mollusc are collected in sea water in two test tubes the solutions will phosphoresce for some time. Boil the solution in one tube and the light disappears instantly; allow the solution in the other tube to stand until the light disappears spontaneously. Then if both tubes, now dark, be mixed, the light reappears. The boiled tube contained luciferin but no luciferase while the other tube contained luciferase but all the luciferin had been oxidized by standing. On mixing, the two substances were again brought into contact and light resulted. In later papers Dubois has studied especially the properties of the *Pholas* luciferin and luciferase and the results are published in many papers in the *C. R. Acad. Sc. Paris* and the *C. R. Soc. Biol.* He says that luciferin is an albumin having acid properties and an active reducing power. It oxidizes readily with luciferase, potassium permanganate, barium peroxide and lead peroxide, giving off light and forming amino-acids and minute crystals giving the test for xanthin.

Luciferase, on the other hand, has all the properties of an enzyme, an oxidizing enzyme acting in the presence of iron salts, which will oxidize luciferin and also tannin, guaiac, a-

napthol, etc. It resembles the oxydones of Batelli and Stern which are destroyed by ether, chloroform and acetone. It passes with difficulty through porcelain and is non-dialyzing. At 60° C. it is destroyed by heat, as also by digestion with trypsin.

It is astonishing that work such as that referred to above, published in well-known journals by a competent physiologist, should have received so little attention. No good account of Dubois's work is to be found in any of the physiologies in English or German, although he is mentioned as the author of the luciferin-luciferase "theory." I have recently been able to confirm a great many of Dubois's statements and to add some new facts. My material has been the West Indian cucullo, *Pyrophorus*,[1] the eastern American fire-flies, *Photinus* and *Photuris*, and luminous bacteria. There is absolutely no doubt of the existence of luciferase and luciferin and the possibility of separating these two substances.

I find that luminous bacteria also contain luciferin in very small amount and this can be precipitated by treating the bacteria with absolute alcohol and drying quickly. Such a dry powder gives no light with water, but a faint light with the luciferase of the fire-fly. I have been unable to obtain luciferase from the bacteria, due probably to the fact that, like so many of the bacterial enzymes, it is present as an endoenzyme and can only be extracted by high pressures. Curiously enough the bacterial luciferin can not be obtained by destroying the luciferase through heat. Lack of space does not permit of a discussion of this here, but the full details will be published later.

Luciferase of one form will act with luciferin of another, and *vice versa*. This is true for the two genera of eastern fire-flies (*Photinus* and *Photuris*) and for the West Indian *Pyrophorus* (*Elsteridæ*) and *Photuris* or *Photinus* (*Lampyridæ*). Fire-fly luciferin will give no light with extracts of non-luminous parts of the fire-fly or with non-luminous insects or extracts of pill bugs, earthworms or slugs.

Whether the luceferin and luciferase of all forms are identical is still an open question. We know of many organic substances such as oils, alcohols, lophin, etc., which will phosphoresce at relatively low temperatures with alkalies, so that it would be by no means remarkable to find that the luciferin of different forms was different. I have this past winter discovered a luminous reaction which is remarkable in many ways and which closely parallels the method of light production in luminous forms. Pyrogallol will produce light with the vegetable oxidases (potato or turnip juice) if we add some hydrogen peroxide. As little as one part of pyrogallol in 254,000 parts water ($m/32,000$) will give perceptible light and $m/8,000$ a good light. Faint light is produced at 0° C. and a good light at 10° C. A characteristic of luminous animals is that they still produce light at 0° C. The pyrogallol + H_2O_2 corresponds to luciferin and the vegetable oxidase to luciferase. Like the luciferase of luminous forms the oxidase is destroyed by boiling. We might therefore separate a luminous mixture of pyrogallol + H_2O_2 and potato juice into a thermostabile and thermolabile component which would again give light if brought together. Mammalian blood may take the place of the oxidase of plant juices.

In a general way, then, we may say that the problem of bioluminescence has been solved at least in its broad aspects. There still remain many details to be filled in, details which will take some time to complete. The exact chemical nature of luciferin is unknown, but the method of attack of the problem has been outlined and all that is necessary is a sufficient quantity of the luminescent material for the determination of its chemical nature. That it may be difficult to obtain enough for analysis is indicated by the luminescence of pyrogallol which takes place in the almost inconceivably small concentration of 1 : 254,000.

E. NEWTON HARVEY

TOKIO, JAPAN,
May 1, 1916

[1] My studies of *Pyrophorus* were made under the auspices of the department of marine biology of the Carnegie Institution of Washington.

SPECIAL ARTICLES

ON THE ASSOCIATION AND POSSIBLE IDENTITY OF ROOT-FORMING AND GEOTROPIC SUBSTANCES OR HORMONES IN BRYOPHYLLUM CALYCINUM

Recent experiments have led me to results which suggest that the substances responsible for root-formation in the stem of *Bryophyllum calycinum* are associated or possibly identical with the substances responsible for geotropic curvatures of the stem of this plant.

1*a*. When we cut out a piece of the stem of *Bryophyllum* and suspend it horizontally in a vessel saturated with water vapor, the stem will bend to such an extent that it assumes the shape of a U, the concave side being on the upper side. It was found that this geotropic curvature is due to a growth (or some other form of active stretching) of the cortex in the convex region of the lower half of the stem. The upper half of the stem is bent passively through the growth of the lower half. This was ascertained by measurements on marked stems split longitudinally, and suspended horizontally.

1*b*. It was found that root-formation appears generally in that node around which the curvature takes place and that it is confined in the bending region to the nodes on the lower side of a horizontally suspended stem. It is thus seen that the geotropic growth (or active stretching) and the root-formation both take place on the lower side and in the same region of the stem.

2*a*. When we cut out a piece of stem from *Bryophyllum* containing from four to seven nodes (but with the two most apical nodes cut off) and if we remove all the leaves such a stem will form roots at the two most basal nodes (and sometimes also at the basal surface) and new shoots at the two most apical nodes, but this new growth is extremely slow. If, however, a leaf is left on the stem the new organs will grow out much more rapidly.

2*b*. When such a stem without leaves is suspended horizontally it will bend geotropically, but the bending will take place very slowly. If, however, a leaf is left on the stem the geotropic curvature takes place with much greater rapidity.

3*a*. When we remove all but one apical leaf on the lower side of such a horizontally suspended stem, the stem will form roots first in the second node from the leaf; but only from the node on the under side of the stem. Roots will also grow out from the two most basal nodes.

3*b*. In the same stem the geotropic curvature will occur in the region where the first growth of roots takes place; namely around the second node behind the leaf.

4*a*. When all the leaves are removed with the exception of one leaf in the basal node (on the under side of the horizontally suspended stem), root-formation will be scant and will only take place at the cut surface at the basal end of the stem behind the leaf; and sometimes also from the axilla of the leaf.

4*b*. In such a stem the geotropic curvature is generally considerably less than when an apical leaf is left and is confined to the piece of internode behind the leaf and to the immediate neighborhood in front of the leaf.

5. In all these experiments the region of curvature (and of growth of the cortex) coincides with the region where the most rapid growth of the roots takes place (or where root-forming substances or hormones collect).

6. The effect of the position of a single leaf on the stem is much more striking when we remove the upper half of the cortex in a horizontally suspended stem of *Bryophyllum*. Such stems become at once very strongly convex on the upper side, due to the release of the passively contracted wood and pith on the upper side, where the cortex is removed. When in such a stem all the leaves are removed except the one on the lower side at the apical end of the stem, the latter will gradually overcome the convexity on the upper side and assume the geotropic U shape with the concavity on the upper side due to geotropic growth of the cortex on the lower side of the stem, in the region around the second node behind the leaf. If, however, the leaf is left at the basal end no geotropic curvature will occur (at least none appeared as long as the stems were observed). If the cortex is removed on the lower side no geotropic curvature is possible since this curva-

ture is due to the growth of the cortex on the lower side of the stem.

7. It is known that the geotropic "stimulus" can travel around a corner, *i. e.,* around an incision through half the thickness of the stem, which is to be expected if the "stimulus" consists in the flow of a liquid. If such incisions are made alternately across the upper and lower half of each internode of a horizontally suspended stem with only one leaf on the under side, the stem will show geotropic curvature if the leaf is in the apical node; but will show as a rule no curvature if the leaf is in the basal node; or a slight curvature in the neighborhood of the basal node may occur after considerable delay.

8. All these experiments agree with the assumption that each leaf sends a current of root-forming substances towards the base of the stem, and a current of shoot-forming substances towards the apical end of the stem; that the root-forming substances have a tendency to collect at the lower side of a horizontally suspended stem, and that they are associated or identical with the substances causing the growth of the cortex on the lower side of the stem to which the geotropic curvature is due.

9. This idea is further supported by experiments with stems split into two longitudinally. If such split stems are suspended horizontally only those halves show geotropic curvatures whose cortex is below. If the cortex is above (and the cut surface of the stem below) almost no geotropic curvature takes place, no matter where the leaf is, for the simple reason that such stems are lacking the cortex on the lower surface. If the cortex is below and one leaf left at the apical end, root-formation will take place just as rapidly as in the intact stem and geotropic curvature still more rapidly (since the passive resistance of the upper half is removed). If, however, the leaf is left at the basal end, in about 50 per cent. of the cases no geotropic curvature takes place, or if it takes place it is confined to the region of the basal node; and is considerably less than if the leaf is left at the apical end.

If the pieces have no leaf they will bend more strongly than when a leaf is left at the basal end only, thus indicating a possible inhibiting influence of the basal leaf upon the curvature in the more apical regions of the split stem.

10. All these facts suggest a close association if not identity between the root-forming substances and the substances (or hormones?) causing geotropic curvatures. Such a close association or identity between organ-forming and geotropic substances might also explain why it is that in some cases geotropism can restore the form in the same way as does regeneration, as, *e. g.,* in certain fir trees, where one of the upmost horizontal branches will begin to grow vertically when the apex is cut off.

JACQUES LOEB

THE ROCKEFELLER INSTITUTE FOR MEDICAL RESEARCH, NEW YORK

THE AMERICAN CHEMICAL SOCIETY

THE 52d meeting of the American Chemical Society was held at the University of Illinois, Urbana-Champaign, April 17 to 21, 1916. The meeting was an unusually enthusiastic one, the total registration being the largest to date, namely, 728. A detailed description of the social and other events of the meeting will be found on page 396 of the *Journal of Industrial and Engineering Chemistry* for May, 1916. The general meeting and meetings of the Divisions of the Society were held in the lecture rooms of the chemistry building of the University of Illinois. Some notable features were presented in the "Special Program for Home Economics" by the Division of Biological Chemistry; in the "Symposium on the Activated Sludge Method of Sewage Purification," by the Division of Water, Sewage and Sanitation, and in the "Symposium on the Chemist in Food Control," by the Division of Agricultural and Food Chemistry.

The following general addresses were given:

The Composition of Corn as affected by Nineteen Generations of Seed Selection: L. H. SMITH. (Lantern.)

The Manufacture of Chemical Apparatus in the United States: ARTHUR H. THOMAS.

The War and the American Chemical Industry: RAYMOND F. BACON.

On the Influence exerted by Electrolytes on the Equilibrium of Emulsions, Jellies and Living Cells: G. H. A. CLOWES. (With demonstration.) (Lantern.)

Some Effect of High Pressures: John Johnston. (Lantern.)

Public Lectures. Complimentary to the citizens of Champaign and Urbana.

Charles L. Parsons, "Production of Radium," illustrated by lantern slides and moving pictures.

Curtis F. Burnam, "Use of Radium in Treatment of Cancer," illustrated.

All divisions of the society held well-attended meetings. The titles of papers presented follow with abstract so far as abstracts could be obtained.

DIVISION OF AGRICULTURAL AND FOOD CHEMISTRY

L. M. Tolman, *Chairman*

Glen F. Mason, *Secretary*

Cattle Foods: Carl S. Miner.

Starch and Glucose: A. P. Bryant.

The Chemist in the Canned-food Industry: W. D. Bigelow.

The canner, like other manufacturers, sometimes finds it advantageous to have miscellaneous supplies examined. The laboratory finds a greater field of usefulness, however, in determining the cause of and finding a means of preventing various kinds of spoilage and real and apparent inferiority. This sometimes involves the systematic study of methods of canning in order that the exact technique that will uniformly give the best results may be accurately defined. All this work requires an intimate knowledge of the technology of the industry. Laboratories frequently make serious errors in answering questions submitted by canners, because of an imperfect knowledge of the facts. Errors of this sort do great damage to the industry and work injury to the reputation of the chemical profession. Greater care on the part of chemists is urged in such matters.

The Chemical Control of Gelatin Manufacture: J. R. Powell.

Chemical control has been limited until quite recently, but when demanded by the advance in food requirements, its installation has proved of value to the manufacturer. This control covers the inspection of raw material and chemicals; the control of the actual manufacturing process, and the inspection of the finished product and by-products. Raw material is examined for its yields and the presence of interfering impurities. Manufacturing processes require such attention as will prevent the introduction of impurities, and the deterioration of the gelatin. The finished product is examined to judge its commercial value, and suitability for food purposes.

Flour: Harry Snyder.

The Removal of Barium Chlorid from Table Salt: W. W. Skinner.

A preliminary investigation by the Bureau of Chemistry showed that salts of certain grades contain considerable amounts of barium chlorid. As barium chlorid is a poisonous substance the use of such salt in food products is a menace to health. Therefore, the elimination from the market of salt containing barium chlorid in any appreciable quantity is highly desirable.

A method of treatment has been developed for the removal of the barium from the brine. This method depends upon the addition of sodium sulphate and calcium oxide in proper proportions and the blowing of air through the treated brine to decompose the ferrous bicarbonate, naturally present, thus obtaining a rapid precipitation. The method gave such promising results in the laboratory and from a test run of six days in the works, that one large salt manufacturer decided to try it out and installed the necessary equipment for the treatment of 200,000 gallons of brine per day. The treatment was begun in September, 1915, and has been in operation continuously ever since. The results so far obtained indicate that the process is a complete success. Ordinarily two and sometimes three grades of salt are produced. Since the installation of the process, however, the entire output of the plant has been of the No. 1 grade known to the trade as table and dairy salt. No off grade or No. 2 salt is produced. The cost of treatment is estimated at from 1¼ to 1½ cents per barrel. About sixty thousand barrels of salt containing only insignificant traces of barium have been produced by the new process.

Flavoring Extracts: George Lloyd.

The High Character of the Manufactured Foods offered the Public To-day: A. V. H. Mory.

Experience gained from careful examination of several hundred samples of manufactured food products, representing nearly all varieties, shows that adulteration and misbranding are seldom met with to-day in the goods of reputable producers, and that the adulteration that represents a serious menace to health is practically non-existent.

About the only service the laboratory of a large distributing house has been able to render is that of helping the expert buyers to select the best from a number of perfectly legal and wholesome products submitted for consideration; all of which is a testimonial to the present efficiency of law enforce-

ment made increasingly efficient by cooperation on the part of the reputable producer and distributer, who finds in the enforcement of these laws the elimination of unfair competition.

Preventing the Staling of Bread by Cooling in a Predetermined Atmosphere: Arnold Wahl.

Bread and like products absorb while cooling a considerable volume of gas from the atmosphere in which it rests, due to a vacuum caused by the physical condensation of the carbon dioxide in the pores of the loaf and by the solution of carbon dioxide in the free water of the bread, the solubility increasing as the product cools. Bread cooled in an atmosphere of oxygen becomes stale in a few hours while bread cooled in an atmosphere of carbon dioxide is so modified as to remain fresh for several weeks, the reason being that in the former case oxidation of the protein occurs similarly to the effect of oxygen on the nitrogenous constituents of beer, while in the latter oxidation is prevented. I prefer to employ carbon dioxide freshly produced by fermentation for this purpose, having been determined by long experience in brewing to be best suited to combine chemically with nitrogenous food substances.

Use of Picric Acid in Meat Sugar Solutions: W. B. Smith.

Proteoses, peptones and the greater portion of the amino-acids are removed from meat extracts by excess of picric acid combined with excess of phosphotungstic acid in aqueous solution. More amino-phosphotungstates are removed by adding hydrochloric acid to the filtrate.

Little free hydrochloric acid remains, permitting estimation of reducing sugar if quickly done. Bertrand's copper solutions and Low's iodid method are used. Total sugar is determined after inversion.

Mercuric acetate, followed by phosphotungstic and hydrochloric acids, gives the same results, but removal of excess mercury is essential. Picric acid does not interfere with reduction of Fehling's solution.

The Analysis of Maple Products VIII. The Application of the Conductivity and Volumetric Lead Subacetate Tests to Maple Sugar: J. F. Snell and G. J. Van Zoeren.

A representative sample of the sugar, say 100 grams, is dissolved in hot water, boiled to 219° F. (103.9° C.) and filtered through cotton wool. The resulting syrup is tested as directed in Papers VI. and VII. Pure products give conductivity values and volumetric lead values within the limits reported for genuine syrups in Papers VI. and VII.

Chinese Preserved Eggs—Pidan: Katharine Blunt and Chi Che Wang.

Pidan is a kind of Chinese edible preserved eggs made by covering fresh ducks' eggs by a pasty mass of lime, wood ashes, salt and tea, and finally rice hulls. It is solid, the yolk and white still separate and very dark colored, and with remarkably ammoniacal odor. The moisture of pidan yolk is higher than that of fresh ducks' eggs, and of the white very much lower, hence water has been transferred from the white to the yolk and lost to the air. The ether extract of the yolk is low (only 21 per cent.) and its acidity high (8 per cent.). The ash is high and alkaline. Coagulable protein is lower than fresh hens' eggs, and, the most marked change, ammoniacal nitrogen by Folin's method is extraordinarily high (0.06 per cent. determined on the filtrate from the coagulable nitrogen).

A Study of American Beers to show the Effects on Their Composition of Various Raw Materials used in Their Production: L. M. Tolman and J. G. Riley.

Division of Agricultural Chemistry

The Effects of Plant Foods upon the Amount and Quality of Substances used for Foods, particularly Fruit and Vegetables: H. A. Huston.

Does the Oxidation of Tetrathionate to Sulfur affect the Accuracy of the Estimation of Thiosulfate by Means of Iodine? Philip L. Blumenthal and S. D. Averitt.

In neutral or barely acid solutions, an excess of iodine oxidizes tetrathionates to sulfates. Experiments showed an oxidation of 18 per cent. of the total sulfur in two weeks, with the excess of iodine as 2:1. Whenever thiosulfate is titrated with iodine, a small amount of sulfate is formed. This does not cause an appreciable error when N/10 solutions are used. In the analysis of lime-sulfur solutions by iodine titration, the volumetric results on thiosulfate agree very closely with the value obtained by oxidizing the tetrathionate with bromine weighing as $BaSO_4$. The sulfate formation noted might be due to presence of a little sulfite, but there is reason to believe none is present.

Separation and Estimation of Polysulfides and Thiosulfate in Lime Sulfur Solutions: S. D. Averitt.

The quantitative separation of polysulfides preparatory to the determination of thiosulfate is accomplished by means of standard solutions of iodine or hydrochloric acid using appropriate indicators.

Water	1,000	gm.
Saccharose	50	"
Sodium nitrate	2.0	"
Potassium dihydrogen phosphate	1.0	"
Magnesium sulphate	.25	"
Potassium chloride	.25	"
Ferrous sulphate	.01	"
Calcium carbonate	40	"

The form in which nitrogen is supplied and also the amount of nitrogen are the most important factors when growth is conducted in the absence of calcium carbonate. Cultures which produce no citric acid when grown in the above media with 3.0 grams of sodium nitrate per liter will produce very considerable amounts of citric acid if the sodium nitrate be reduced to 1.2 grams per liter.

The most favorable media found for the production of free citric acid was

Water	1,000	gm.
Saccharose	50	"
Ammonium dihydrogen phosphate	2.0	"
Magnesium sulphate	.25	"
Potassium chloride	.25	"
Ferrous sulphate	.01	"

On this media several strains of *A. niger* will produce almost pure citric acid with only traces of oxalic.

Growth was conducted on 50 c.c. of media contained in a 200 c.c. Erlenmeyer flask at 30° C. Cultures were examined at 6 to 10 days of age. The cultures employed were obtained from Dr. Charles Thom.

The influence of hydrogen ion concentration, the substitution of other sugars for saccharose and the influence of numerous inorganic salts on this reaction have been studied but can not be reported in detail at this time.

The Equation of Fermentation of Glucose by Bacillus coli communis: Oliver Kamm.

The acid, alcohol, gas fermentation of glucose by *B. coli*, as given by Harden,[2] was found to be a combination of several fermentations. In particular, the lactic acid fermentation was found to proceed independently. In the absence of most inorganic salts and especially of phosphates, evidence was obtained that the gas formation (carbon dioxide and hydrogen) is due to the secondary fermentations of formic acid.

The Liberation of Ammonia from Ammonium Salts by B. Coli Communis: Robert Bengis and A. R. Rose.

A synthetic medium containing ammonia lactate and ammonia phosphate was used in growing *B. Coli communis* in quantity. The bouillon, when aerated, lost appreciable amounts of NH_3 and the amount that could be removed in this way was increased by inoculation with *B. Coli communis*. In agar media the amount of ammonia given off under sterile conditions was very minute, but upon inoculation with *B. Coli* more NH_3 was liberated than in the bouillon media.

[2] *J. Chem. Soc.*, 79 [1], 610–28.

The Change in Urinary Constituents following the Feeding of B. Coli Communis: Arthur Knudson and A. R. Rose.

The dogs were kept on a basal ration for long periods. This ration consisted, in part, of a fixed amount of bouillon which was inoculated at stated intervals with *B. Coli communis*. There was a rapid increase of indican and etherial sulfur eliminated in the urine following the inoculation of the bouillon, but these gradually decreased for a period of 2 to 3 weeks to the status of the normal periods, though *B. Coli* was still introduced. After a period of rest from *B. Coli*, the inoculation again produced an increase in these two constituents in the urine of the dogs, with the same gradual decrease. Other changes were noted.

The Analysis of the Urine as a Part of the Physical Examination of the College Student: G. O. Higley, E. T. Lowrey and C. T. J. Dodge.

This work was begun in September, 1915. From the urine voided by the student at the close of the physical examination a sample was taken and tested for albumen and dextrose and, in some cases, for other pathological substances. If any such substance was found, the student was advised to consult a physician. Also, the student's urine was reexamined twice, at intervals of a month or so, if found necessary.

Of 426 students who took the test, the urine of 15 showed albumin in two successive tests, and 5 showed sugar. A strong test for bile was obtained in one case. This work will be continued next year.

Plant Immuno-Chemistry: R. W. Thatcher.

The question as to whether there is in plants a series of phenomena comparable to those of antibodies in animals has not yet been settled, but is now being investigated. Two general methods of investigation are being employed: (*a*) a comparative biochemical study of the composition of healthy and diseased plants, and (*b*) a biochemical and microchemical study of the reactions produced in the host by the growing parasite. Sufficient progress has been made to justify the recognition of two types of resistance, or immunity; (*a*) an antagonism of the tissue substances of the infected plant to the action of the enzymes or other agents excreted by the growing hyphæ of the parasite, and (*b*) a hyper-sensitiveness of the host, whereby its tissues at the point of entrance of the

parasite are killed and no longer supply nutrient material for the latter, thereby causing its death by starvation.

The Presence and Origin of Volatile Fatty Acids in Soils: E. H. WALTERS.

In a recent examination of a sample of Susquehanna sandy loam soil from Texas acetic acid and propionic acid have been isolated and identified. The soil was found to contain approximately 41 parts per million of acetic acid and 13 parts per million of propionic acid.

In determining the kinds and amounts of volatile acids produced during the decomposition of green manure it was found that 98.5 c.c. $N/10$ acetic acid and 49.5 c.c. $N/10$ propionic acid were produced from 100 grams of rye when this amount of finely ground material was mixed with one kilogram of soil and allowed to decompose for six months under optimum moisture conditions in a loosely covered jar. During the decomposition of alfalfa under similar conditions it was found that 44.6 c.c. $N/10$ acetic acid and 35.4 c.c. $N/10$ propionic acid were produced from 100 grams. Methods used in the isolation and estimation of these acids are described in detail.

On the Reaction of the Pancreas and other Organs: J. H. LONG AND F. FENGER.

These investigations are in part a continuation of those reported at the Seattle meeting. In a large number of qualitative tests it was found that the pancreas "press juice," obtained by centrifugal action, is constantly acid in the organs of hogs, beef and sheep. The P_H values, the hydrogen coefficient or potential, were found to vary within narrow limits, 5.5 to 5.7.

The livers of a number of animals and the press juice from the parotid glands of cattle were likewise found acid. An acid reaction was recognized also in the juice of the spleen of hogs, but the liquid from the thyroid was practically neutral. Some explanation of the possible reason for this variation in reaction is discussed.

The pancreas reaction is undoubtedly an important physiological phenomenon and the source of the acidity was found to lie in two directions. A complete quantitative analysis of the salts in the press juice shows that they consist largely of alkali phosphates, with potassium acid phosphate in largest amount. A combination of the various ions determined discloses the fact that the solution must have an acid behavior. Another source of acid reaction is found in the character of the nucleo-proteins present. Among these the α-proteid of Hammarsten is probably the most important.

Contributions of Chemistry to the Science and Art of Medicine: L. J. DESHA.

The fundamental relationship between chemistry and medicine is emphasized by a résumé of chemical contributions to progress in physiology, pathology, therapeutics, diagnosis, etc. Such contributions will be increased by providing more men adequately trained in both chemistry and medicine. The question is raised as to the feasibility of providing for regularly trained chemists a special one- or two-year course in those branches of medicine most intimately related to chemistry. A field for such men exists in teaching the new medical chemistry, in research, and particularly in the widening applications of quantitative methods in diagnosis.

Chemical Aids in Diagnosis. I. A Comparative Study of the Tests of Renal Function: L. J. DESHA.

A preliminary report is made including the data on thirty-six cases in which the Hedinger-Schlayer-Mosenthal test diet has been used. The normal standards and diagnostic advantages set forth by Mosenthal are in general confirmed. The Greenwald precipitation of the blood proteins has been successfully employed. Most cases with established nephritis show increased nonprotein nitrogen in the blood, but there appears no close relationship between this value and prospective fatal termination. The work is being continued to include the Ambard and other tests.

Oxalic Acid and its Salts in Foods and Spices: ARNO VIEHOEVER AND JOSEPH F. CLEVENGER.[3]

Information is given as to the presence and distribution of oxalic acid and its salts in foods and spices. Some of the data are taken from literature and some are the results of a special microscopical and microchemical investigation.

Oxalic acid is present in many of our daily foods, usually in the form of calcium oxalate. Very small amounts of oxalic acid have been reported in potatoes, cabbage and pickles, where its presence was not detected microscopically by us. No calcium oxalate has been found so far in peas, carrots, parsnips, kale, cranberries or any of the cereals.

A new specific microchemical reaction with resorcin sulphuric acid was applied.

On Some Proteins from the Jack Bean, Canavalia ensiformis: CARL O. JOHNS AND D. BREESE JONES.

When meal made from the Jack bean was extracted with 10 per cent. sodium chloride about 10

[3] Contribution from the Pharmacognosy Laboratory, Bureau of Chemistry, Washington, D. C.

per cent. of globulin was obtained by dialyzing the extract. This globulin was composed of two proteins which may be separated by fractional precipitation with ammonium sulphate. These are designated globulin A and globulin B. Globulin A was present in very small amount and gave the following figures: $C = 53.35$, $H = 6.95$, $N = 16.62$, $S = 0.81$, $O = 22.27$. Globulin B, which was the chief protein present, gave the following percentages: $C = 53.21$, $H = 7.02$, $N = 16.77$, $S = 0.51$, $O = 22.49$. The nitrogen in globulin B was distributed as follows: Humin nitrogen 0.30, amide nitrogen 1.40, basic nitrogen 3.17, non-basic nitrogen 11.53, total nitrogen 16.40.

An albumin of the legumelin type was also obtained from the Jack bean. This gave the following figures: $C = 53.23$, $H = 6.99$, $N = 16.30$, $S = 0.87$, $O = 22.61$. The nitrogen was distributed as follows: Humin nitrogen 0.23, amide nitrogen 1.16, basic nitrogen 3.73, non-basic nitrogen 11.18, total nitrogen 16.30.

On an Alcohol-Soluble Protein from Kafir-Corn, Andropogon sorghum: Carl O. Johns and J. F. Brewster.

About three per cent. of an alcohol-soluble protein was obtained by extracting kafir-corn meal with hot 70 per cent. alcohol. The purified protein gave the following percentages:

$$C = 55.41,\quad H = 7.25,\quad N = 16.38,\quad S = 0.62,\quad O = 20.34$$

The nitrogen distribution calculated from a Van Slyke analysis was as follows:

Humin nitrogen	0.17
Amide nitrogen	3.46
Basic nitrogen	1.04
Non-basic nitrogen	11.97
Total nitrogen	16.64

The distribution of the basic nitrogen, calculated to the per cent. of amino acids in the proteins, was as follows:

Arginin	1.58
Lysin	0.90
Cystin	0.78
Histidin	1.00
Tryptophan present.	

While this protein resembles zein from maize in its ultimate composition, it differs from zein which is lacking in lysin and tryptophan. Further investigations are in progress.

A Synthesis of Tetracarbonimid: David E. Worrall and Marion K. McNamara.

The oxidation of uric acid by hydrogen peroxide in alkaline solution results in the formation of tetracarbonimid. This substance has been synthesized in this laboratory by heating, in alcoholic solutions, molecular amounts of carbonyl dimethan and urea. The two substances slowly combine with the elimination of two molecules of alcohol

$$OC\begin{cases} NH\cdot CO\cdot OC_2H_5 \\ NH\cdot CO\cdot OC_2H_5 \end{cases} + \begin{matrix} H\,H - N \\ H\,H - N \end{matrix}\Big\rangle CO$$

$$= OC\begin{cases} NH\cdot CO\cdot NH \\ NH\cdot CO\cdot NH \end{cases}\!\!\rangle CO + 2C_2H_5OH.$$

A Chemical and Bacteriological Study of some Non-Pathological Gastric Residuums: Chester C. Fowler, Max Leviné and Sue B. More.

The contents of forty fasting human stomachs free from gastric symptoms were examined for free and total acid, pepsin, trypsin and bile. The volumes and physical characteristics were noted and the number and kinds of organisms determined by plating on wort agar and plain and glucose agar.

The stomachs fall into three groups: (*a*) practically sterile, (*b*) containing less than 2,000 organisms per c.c., (*c*) containing more than 4,000 per c.c.

There were three main groups of yeasts, (1) not producing gas from substance tested, (2) forming gas from glucose, fructose and galactose, (3) forming gas from these mono-saccharides and maltose.

Many of these yeasts formed acetyl-methyl-carbinol ($CH_3CHOH\cdot CO\cdot CH_3$).

A Study of Eighty Samples of Gastric Residuums obtained from Apparently Normal Women: Chester C. Fowler and Zelma Zentmire.

Sixty women were the subjects of this experiment. Twenty-one submitted to the collection of samples a second time; making a total of eighty-one samples.

The determinations made were: total and free acid, pepsin and trypsin.

The averages obtained were: volume 49.44 c.c., total acid 30.31 c.c. ($N/10$ alkali to neutralize 100 c.c. of juice), free acid 15.63 c.c., pepsin 3.32, and trypsin 5.22.

A marked constancy in the residuum of the same individual at different times was noted. In general the results of Fowler, Rehfuss and Hawk obtained on men at Philadelphia were confirmed.

Charles L. Parsons,
Secretary

(*To be continued*)

SCIENCE

Friday, August 18, 1916

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

THE BASIS OF INDIVIDUALITY IN ORGANISMS[1]

INTRODUCTORY

To enter upon the "higher criticism" of the concept individuality, is far beyond my powers. Even the humble attempt to think of it, in the organic realm, in what I conceive to be the simplest terms, offers difficulties most of which must be bequeathed in their entirety to future generations. Yet to point these out and to take a few soundings, unsatisfactory though they be, may not prove entirely futile even at this time.

For me, the basis of individuality in organisms is the mechanism by which living things, despite profound and constant change, keep themselves capable of identification. Some of the changes through which organisms pass are so radical that by common consent we treat them separately under the head of development, but since there is no evidence that living things become individuals at a particular point in their history, we may expect to find anywhere in the life-cycle the mechanism upon whose workings the possibility of identification rests. For obvious reasons the arrangements that make for constancy must occur in their least complicated form in the simplest of all the stages of development.

Fortunately, since it forces us at once to engage with fundamentals, the beginnings of development offer no refuge from our most insistent problem. We habitually identify a given organism at two more or

[1] Read at a joint symposium of the American Society of Zoologists and Section F of the American Association for the Advancement of Science, Columbus, Ohio, December 30, 1915.

less remote points of time, but no biologist limits himself to this relatively simple pursuit, since every living thing can be, at least partly, identified also with the better known portions of its ancestry. Indeed, these so-called genetic similarities are so striking and constant that one generation can be inferred from another with considerable precision.

If there is a substantial basis for the resemblances between parents and offspring, it must be the chromatin, for this is the only material capable of being contributed to each generation in essentially equivalent values by all the members of a given lineage. But if chromatin is responsible for the partial identifications possible between the individuals of two or more generations, we must also suspect that the specific recognition of a given individual at any of the numerous phases of his life is traceable to the same source.

THE SYNTHESIS OF CHROMATIN

Strictly speaking, "chromatin" is a morphological concept. Chemical analysis shows that it contains a conjugated phospho-protein provided with a nucleic acid group, the latter a complex of phosphoric acid and a nuclein base. During the so-called resting state of the cell, this material appears segregated in the nucleus.

We must attach to this substance a degree of specificity not less exact than the specificities we are seeking to explain. In this we have ample encouragement from cytologists and geneticists. But the question at once arises how chromatin can increase in quantity during more than one life cycle and yet lose none of its original characteristics. Brothers, who in the one-celled state derived from their mother the kind or arrangement of chromatin which in her father was associated with color-blindness, not only exhibit this defect in their own persons, but between the ages of 25 and 55 produce each some 169,692,750,000 examples of the same factor, all traceable to their own original endowment.

Compared with cytoplasm, the nucleus seems meager in the diversity of its chemical make-up. It is free from salts; it is devoid of fats and carbohydrates. Moreover, iron and phosphorus, easily demonstrable in the cytoplasm, are present in nuclei in forms difficult to detect and for that reason spoken of as masked or organic. These facts are not altered by doubting the localization of the iron in chromatin[2] or the accuracy of the tests for organic phosphorus.[3]

From the constancy of their occurrence we must conclude that both elements, as nuclear constituents, are essential. However, their absence in inorganic form, coupled with the general chemical poverty of the nucleus, indicates that simple raw materials for the synthesis of chromatin are excluded by the nuclear membrane (Macallum).

This conclusion is out of harmony with prevalent interpretation. Yet no one need be misled. That nuclei are rendered conspicuous by staining, are scrupulously divided in cleavage and maturation, and combined with equal exactitude in fertilization, are all beside the point. Further, though no cell devoid of a certain proportion of nuclear material can live, it is no less true that a nucleus embarrassed by the loss of cytoplasm also fails to maintain itself. Chromatin, moreover, is present in the bacteria, but not in the form of a nucleus. Here its complete cytoplasmic synthesis is not open to doubt. We are ready enough to admit that the cytoplasm of nu-

[2] References in Aristides Kanitz, "Handbuch d. Biochemie," etc. Herausgegeben von Carl Oppenheimer, pp. 253–254, Bd. II., Teil 1.

[3] R. R. Bensley, *Biological Bulletin*, Vol. X., pp. 49–65.

cleated cells can synthetize fats, carbohydrates, and proteins in general, including the most complicated compound forms. What real evidence have we that nucleoproteins constitute the sole exception?[4]

If we reckon with the synthetic powers of the cytoplasm as a possibility, we must next inquire how these can be influenced by the presence of a specific nucleus. That cytoplasmic response, in general, is dependent on the chemism of the cell, and that these activities are specifically and profoundly modified by changes in the variety of nuclear material present, are well-known facts shown nowhere more clearly than in the structural differentiations called forth in hybrids. These, especially, are important for us since the introduction of nuclei into foreign cytoplasm demonstrates most strikingly their ability to regulate syntheses so that more nuclei like themselves are produced. In what terms are we to conceive this regulation?

The influence of a specific chromatin on cellular processes can be directly attributed to the samples which are known to leave the nucleus and come directly into the cytoplasmic reaction-sphere. But the details of their activity there remain obscure. Autocatalysis, suggested on quite inadequate grounds, is not necessarily excluded by the recent work of Conklin[5] and other effects are also thinkable. A fitness, chemical or physical in nature, between the liberated chromatin or its products, on the one hand, and certain of the reaction-products of cytoplasmic synthesis on the other, leading to the formation of different, or larger, non-reacting aggregates, would automatically increase the production of such substances, provided always the machinery necessary for their production is given at all. Very possibly the reciprocal relation suggested here is one of the keys to successful hybridization.

It is useless to hope for intellectual satisfaction in this matter at the present time. We can, however, assert with confidence that a cell is viable and assured of the possibility of offspring, essentially like itself, if it contains, at the beginning of its life-cycle, samples of all the various kinds of chromatin possessed by its immediate parent, and moreover, contains these in quantities sufficient to influence cytoplasmic syntheses so that they shall ultimately yield a chromosomal complex in which the original proportions among the several variants are quantitatively preserved.

THE SYNTHESIS OF CHROMOSOMES

If chromatin or its immediate forerunners are cytoplasmic in origin, how do they get into the nucleus? The impermeability of nuclear membranes for most constituents of the cell is probable; likewise, their permeability for nucleins, since these, even in the form of visible aggregates, seem to pass freely into the cytoplasm. If they can get through the membrane, going out, they can also get through, going in. The nucleus, therefore, is to be thought of as a kind of sanctuary into which certain proteins may enter, and, so long as they remain behind their wall, be free from the influence of other substances (Macallum).

These considerations are only an entering wedge. We infer a specific chromatin for each race, for every individual, and even for particular cells of the individual. More than this, in its intranuclear state, the chromatin is organized, in all likelihood, permanently, into chromosomes which

[4] For a fuller discussion of the methods, evidence, and conclusions, see the articles by A. B. Macallum in Abderhalden, "Handb. d. Biochem. Arbeitmethoden," and in Ascher-Spiro "Ergebnisse d. Physiol.," VII.

[5] E. G. Conklin, *Journal of Experimental Zoology*, Vol. 12, pp. 1–98.

exhibit symptoms, increasingly serious, of linear differentiation.[6]

If we admit the permeability of the nuclear membrane for chromatin or its immediate forerunners, we can with equal justification attribute the exact character of this membrane to the quantities and qualities of the substances enclosed. Specific permeabilities at once suggest themselves and so, by selective exclusion, any elements not true to one or the other of the types already present within the nucleus may, conceivably, be warded off (Macallum).

Having admitted only specific elements to the nucleus, it becomes our duty to attach them to particular places in specific chromosomes. Here we are, necessarily, thrown on our resources in analogies.

Most suggestive is the behavior of optically active substances in various degrees of dispersion. The common Japanese camphor, dextro-rotatory in alcoholic solution, is also dextral in gaseous as well as solid form. A property therefore which in the highest and intermediate states of dispersal must be attributed to the configuration of individual molecules, is preserved in aggregates of these. This can only result from specific orientation.

Taken alone, this analogy is too simple. It may enable us to form some notion of the terms in which differentiation among the chromosomes is conceivable; but each chromosome, instead of being homogeneous, is, if we can trust ourselves, a system of heterogeneous complexes definitely arranged in space.

Our starting point may again be a relatively simple analog. The hexoses are also systems of heterogeneous complexes definitely arranged in space. While the actual form of the hexose molecule is unknown, the carbon atoms are distributed in a manner conceivable as a linear series in which aldehyde and ketone groups occupy the only positions possible.

Chromosomes, of course, are not large molecules, but aggregates of complexes of these. While the chemical forces determining the specific structure of the individual molecules may be precisely analogous to those which account for the nature of the hexose molecule, aggregation into linear series, in the case of the chromosomes, very likely involves elements not strictly molecular. There is one suggestion, however, that is bodily transferable to the situation presented by the chromosome, namely: factors, in the Mendelian sense, may occupy certain positions because these are the only loci possible.

In this connection, the temporary unions between enzymes and their specific substrates are especially interesting because they depend on the stereo-relations of large complexes of molecules. Conditions, generically similar, may play a determining rôle in the formation of more permanent unions even though these are not chemical. Stereometrically determinable fitness, degrees of fitness, or possibilities of fitness between various regions of persistent differentiated chromosomes and the newly synthetized elements by the lateral accretion or incorporation of which, these regions grow, enable us to visualize not only the periodic restoration of chromosomes to full size, but even the physical requirements for such phenomena as the single and double cross-over.

THE DIVERSITY OF DESCENDANTS

We can hammer out, on the lines suggested, a provisional interpretation of that constancy in organisms which makes us

[6] This evidence has been brought together conveniently by T. H. Morgan and others, in "The Mechanism of Mendelian Inheritance." The Macmillan Co., 1915.

call them individuals. But no two descendants of either compound or unicellular organisms are strictly alike. Each maintains an individuality of its own different from that of its immediate forerunners. This diversity must also be accounted for.

The differences between parents and offspring are adequately explained by the details of maturation. Why, however, do the units derived from the fertilized egg differ? This question is the inevitable consequence of our inability to consider more than one thing at a time. As yet we have neither reckoned with the differential distribution of cytoplasmic substances nor with the intimate history of the chromosomes during and after division.

Students of embryology are familiar with the distribution of "organ-forming" substances. These have been convincingly traced in a number of eggs (Conklin). The remarkable homologies found in the early development of molluscan and annelidan eggs of various types can be understood only as expressions of the accuracy with which these materials manœuver.

The visibility of an "organ-forming" substance is the merest accident. In the egg or cell from which an individual comes there may be and probably are materials whose accurate but uneven distribution during cleavage has not been noticed. Obviously there may be many occasions on which the cytoplasmic composition is changed during development.

Differential localization of itself indirectly increases the possibilities of further differentiation. With increase in the number of cells come purely physical and mechanical disturbances of equilibrium. In the readjustments that follow, changes of relation, themselves certain to influence the greatest variety of subsequent events, are inevitable. A crisis like gastrulation can not but affect, directly or indirectly, every cell in the system.

I am not forgetting the work of the Drieschian school of experimentalists. They have sinned abundantly in this field for the origin of two or four individuals from an egg whose blastomeres are separated at the appropriate moment by no means demonstrates a harmonious equipotential system. Harmonious it probably is, but equipotentiality is proved by meridional divisions only to those who consider them identical with equatorial or latitudinal cleavages. The production of viable organisms from blastulæ has been misinterpreted in the same way.

Differentiation may also be nuclear in origin. Not only are we unable to exclude the possibility of qualitative and quantitative disparities in ordinary mitosis, but we know positively that differences in nuclei may come about after division. We should recall the somatic cells of *Ascaris* and especially the differential growth of chromosomes.

As Conklin has pointed out[7] the chromatin mass does not necessarily double with each doubling in the number of cleavage cells, since growth is not shared proportionately by all the chromosomes. This fact, which very likely does not apply to the divisions of the sex cells, has been observed in the mitoses of early development, divisions which have been but little studied in detail. Such diminutions in the relative sizes of chromosomes may be accompanied by changes in the chromosomal balance and, through this, bring on changes of equilibrium among cytoplasmic processes. Some chromosomes may, in one respect or another, become ineffective, or in their altered circumstances may have effects qualitatively different from their earlier ones.

[7] *Loc. cit.*

CONCLUSION

From the standpoint here adopted, differentiation is the expression of internal as well as external specificities. It is a cytoplasmic reaction and when it occurs denotes that something is not as it was before. Here as elsewhere, we do not deal with isolated events, but correlative changes with specific antecedents and specific consequences. This linkage of specified happenings persists through the entire life-cycle but in the adult, having few or relatively unimportant morphogenetic results, constitutes the basis for a physiology of maintenance.

In development as well as maintenance, that which constitutes our problem is a harmonic relation among all the processes whose net result makes possible the identification not only of an organism at any stage of life, but also of its ancestors. Such constancy, maintained despite the bewildering complexity and multiplicity of processes, is thinkable only in terms of the most rigid determinism.

The results of destroying portions of an embryo, the restoration of lost parts, heteromorphoses, the development of entire organisms from egg-fragments, grafting, the reorganization of an individual from its disjointed cells, and the fluidity of certain types of behavior, are in no sense counter arguments. All that these show is that the equilibria within which specificity is possible, have a certain range. When the eye-stalk of a crustacean regenerates, not an eye, which it does only under certain circumstances, but an antenna, the antenna is species-true, and when the stump grows an eye, which it does under circumstances of a different sort, but no less specific, the eye is not that of a man or an octopus.

If the developmental history of an individual yields a result from which his ancestry can be inferred, what other proof is needed for the accuracy of all the underlying processes? And what need have we who can think through our problems in materialistic terms for regulatory interference by metaphysical vapors? Far from making these things easier to understand, the table-rappings of the vitalist only withdraw attention from the one basis on which we can hope, at present, for a scientific account of the individual at all.

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THE NECESSITY FOR BIOLOGICAL BASES FOR LEGISLATION AND PRACTISE IN THE FISHERIES INDUSTRIES

It is lack of knowledge of the world he lives in that makes civilized man an actual catastrophe to nature's resources and methods.

In this, as in every new country, earlier generations began a series of stupendous economic blunders of turning into cash every natural asset available, blindly regardless of future necessities. Public assets have been, and in some instances are still, legitimate private booty for those whose imagination may be sufficiently keen to see the gold dollar hidden there. It is only within recent years that evidence has accumulated of the imperative necessity of developing the converse method of solving the economic problems of how best to transform free public goods, *e. g.*, lands, minerals, forests, water power, aquatic life, wild birds and quadrupeds, and scenery, into private property or adequately safeguarded public assets. The problem itself is of huge proportions and extensive in its ramifications. We are only beginning to grasp its fundamentalness and to awaken to the extent of our failure to find the correct solution. We still need a system of education which enables the child, the teacher, the parent, the state and federal legislator better to acquire the fundamental facts and their bearings upon human life and human progress. This alone would have made improbable, if not impossible, the present status where in some respects, in any

event, we are dangerously approaching biological bankruptcy and a condition which if not speedily mended will become more speedily beyond recourse. Even over and beyond such earlier blunders as our methods of distribution and alienation of such national assets as the public agricultural domain, mineral and forest lands, the inconceivable slaughter of the wandering herds of buffalo, elk, antelope and deer, of the clouds of migratory birds on land and the fleets of fish, birds and mammals swimming in the sea, much of the capital of this national wealth has been unwisely turned into cash and reinvested in less stable and permanent form of property, and vast sums put into non-productive and depreciating forms of property. To render the future secure, a considerable portion of the primary proceeds must be again converted back into the original form of investment in nature's laboratory. When obliged to do this we see how difficult and costly, even if not impossible, is the process, and how woefully the capital has shrunk as a result of ignorant and selfish manipulation.

An illustration in a very broad sense is our usual method of dealing with our rivers and streams. The fundamental law of water is that a stream may be used, but in such a manner as not to impair its value to property on the stream below. Yet "civilized" man's first conception of a natural stream is that of a sewer, provided by nature for use as such by municipalities, corporations and individuals. The ocean is falsely regarded as the proper ultimate receptacle of all sorts of material débris of civilization. The next generation will be convinced that vast sums have been unwisely expended in construction of "trunk lines of sewers to the ocean," not to mention the cost to the state of the legislation necessary, or of the prodigious waste of nitrogenous material which is diverted from its immediate useful purpose of nourishing vegetation on land, and the irrevocable loss of other valuable recoverable materials valuable in manufacturing and in the arts.

The immediate effects, however, of the biologically and economically indefensible present methods of disposal of manufacturing and municipal wastes are destruction of fish life and menaces to the public health. I am of the opinion that the annual waste of such materials in the little state of Massachusetts alone results in the loss of at least $3,000,000 each year to the manufacturers and citizens in substances recoverable at a relatively small cost. In addition in that state at least $1,000,000 in potential food value could be annually produced in water now for that purpose made valueless or worse, by pollution. There can be no doubt that the present unsatisfactory conditions in the oyster and fish business in general are due to the false impressions of the sanitary condition of fish and shell fish conveyed to the public mind by the appearance of the shores as a result of our indefensible practises in the disposal of municipal and trade waters.

All this is directly connected with our failure to correlate our practises, whether federal, state, municipal or individual, with the essential basic biological principles. Methods and constructions must ultimately be devised and executed to check this vast waste.

As a nation and as individuals we have failed to recognize and to utilize in adequate measure the necessary and correct biological bases for legislation, and though a beginning has been made in many federal departments, including notably among others the Department of Agriculture and the Bureau of Fisheries, progress elsewhere is still retarded and handicapped by unfortunate precedents, by prevalence of local or merely transient expediencies by amateur "near-statesmen" and by personal opinions forcibly expounded by those who have more enthusiasm or authority than special information or training. In general our state and federal governments are open to severe arraignment for obvious failure to equitably and readily secure, to meet required increased production, the transformation into property of those free goods still held in that type of primitive communism which was possible before the development of an increasing population. With reckless haste and too frequently dangerously close to corrupt methods, we have seen the conversion into private wealth of such public assets as not only the forests, fish, birds and quadru-

peds, the products of land and water, but as well much of the public domain itself, both land and water, the agricultural, timber and mineral lands, the sea shores and the lands under water inside the three-mile limit, etc., directly or by indirection, with the result that we have changed the forms of our investment, destroyed nature's perennial dividend producer, only to find after trial on other lines that we must restore nature's plant and methods, be content to assist nature, and to be satisfied with smaller, though more regular increment. The tendency is to replace, frequently at public expense, what the lethargy of the people has permitted to be destructively turned into private property. We burn our forests, then laboriously replant them. We destroy the native birds, and import foreign species to replace them, and even then are compelled to resort to expensive spraying operations to check insect depredations which under natural conditions would have been controlled in considerable measure by birds. We pollute our sources of drinking water, and then devise costly and sometimes ineffective methods of purification. We poison our rivers, and import food fish from wiser nations, or spend our money for outdoor recreation in more far-sighted communities.

Many of the major abuses have happily now come within the public view and into line for ultimate correction. There remain, however, many minor abuses, similar in that they have arisen from the same causes as have the major ones, viz., the personal acquisitive habits of man. These abuses menace the usefulness, even the existence, of many important public assets because in addition they include an underlying biological fallacy which escaped the notice of the legislators. A biological joker in a legislative bill is sometimes more difficult to deal with than the proverbial "colored gentleman in the pile of ligneous fuel" and is a more certain source of trouble. The most prominent weakness in original legislation dealing with wild life, whether fish, birds or quadrupeds, is the too great emphasis upon "don't." Restrictive legislation, piled Pelion on Ossa, at enormous waste of energy and time, frequently fails to meet expectations, for the reason that it usually ignores the question of increased production. It restricts the demand without increasing the supply. In general, for example, legislation restricting the time (close seasons) and manner of taking, unless closely connected with the breeding habits of such species as can not be readily propagated artificially and thereby made independent of the natural conditions necessary for existence, fails to be effective, in that in many cases they do not increase the supply in proportion to the restriction upon demand. The true method is to increase the annual production by bringing about conditions which augment the number of eggs or young produced and brought to maturity, by minimizing the enemies which prey upon young and adults, by improving the feeding conditions, inducing more rapid growth or improved qualities. Both the terrestrial and aquatic conditions are closely similar and require practically identical treatment. We more quickly, however, detect changing conditions on land and apply the proper remedy without loss of time.

The Pilgrim Fathers had scarcely become fairly settled at Plymouth, where fish were so abundant that it was "enacted by the Court, that six score and 12 fishes shall be accounted to the 100 of all sorts of fishes," before establishing by Article 8 of the laws of 1623, that principle of public rights which has opened at once the wealth of Croesus and given opportunities to the modern Aeolus of legislative bodies, that "fowling, fishing and hunting be free to all inhabitants of this government, provided, that all the orders from time to time made by the General Court for the due regulation of fishing and fowling be observed in place or places wherein special interest and property is justly claimed by the Court or any particular person."

This marks the beginning in this country of the principle of primitive communism which had a basis in genuine altruism, and which beyond doubt then met existing conditions, as seen by those who could not forecast the future and whose mental point of view and horizon was obstructed by unfortunate experiences across the sea.

Present conditions, however, render imperative a modification of this view. Restrictive legislation which is the logical concomitant of this primitive communism, no longer meets the situation. Agriculture has passed through this stage of evolution, into which the fisheries, the wild birds and quadrupeds are now entering, and already species have passed beyond recall as a result of this method of treatment. During a period of scarcity of corn, wheat or potatoes we do not legislate for a "close season" or to limit the quantity to be taken in a day, or to prescribe the methods of taking or marketing, but we use every intelligent device available for stimulating an increased production. Similarly, for example, a close season and a limit upon the day's catch did not prevent the commercial extirpation of the scallop (*Pecten*) in certain localities. The fundamental fact necessary for recognition was that here is a specialized animal which breeds but once in its life time, viz., when one year old; the only adequate remedy possible was to save the young under one year old, permit them to breed, and then in the following autumn and winter market the adults before the end of their natural life.

In the case of the lobster (*Homarus*) the reverse condition obtains. The lobster produces approximately 97 per cent. of the normal total number of eggs after it has reached the size of 12 inches and an age of five to eight years. These breeding lobsters are then beyond the danger from all enemies except man. To prevent an undue diminution of the productive capacity of the lobster as a race the adults which have reached the breeding age must be conserved by uniform laws, if we are to have an annual supply of young produced.

The public and the legislators in relation to the oyster problem have passed the purely biological stages where the methods of increased production were involved and the problem now is to secure legislation for permitting increased production by adequate and well known methods, and to reassure the public upon the sanitary problems involved in the production, distribution and marketing, in order that the market may readily absorb the increasing quantities which can be produced, and thus have the benefit of one of the most important sources of a cheap and valuable food, as yet relatively unexploited.

The crab, shrimp, spiny lobster, are already feeling the effects of over-exploitation, and of neglect to consider proper methods for increasing the required production. The dogfish, destroying more food fish than are marketed, is to-day putting an enormous burden upon the fisherman, and through these upon the fish-consuming public. The existing conditions are unappreciated because unseen. The ocean has not yet become apportioned for purposes of securing increased efficiency of food production. The first evident signs are the world-wide acknowledgment of the desirability of extending the national three-mile limit. It is a significant feature that while the reason given is the increased range of gun fire, the chief opponents are those who wish to carry on commercial fisheries as close as possible to the shores of other nations, or of states. The recent quahaug war in Nantucket Sound, though a minor incident, has its significance. An extensive bed of hard clams, locally called "quahaugs" (*Venus mercenaria*) was discovered just outside the three-mile limit off the mouth of Nantucket Harbor, Mass. The opportunity for "easy money" was quickly and widely apparent and steam dredges from other states speedily "spoiled the market" for the local Nantucket hand-takers. Much bitterness was developed among the fishermen, and on account of the undeveloped facilities for distribution the public failed to secure a just advantage. The future stocking of the surrounding shallows was postponed by destruction of this bed of old spawners, designated as "blunts" in the trade, which yield a low market price compared to the young or "little necks." This vast expense of sandy shallows outside the "three-mile limit" to the edge of the continental plateau is a submarine plain, richer even than the Mississippi Valley in potential capacity for producing human food, but is relatively small when compared with the population which even now depends upon it for its sea-food. With the same degree of support accorded to the Bureau of Fisheries as the agri-

cultural interests have accorded to their department, this territory can be made as productive as the best farming and grazing lands of the nation.

We are but pioneers in this field, and, like our forefathers, may never see the realization of our dreams, but just as they pictured in prophecy the boundless fields of wheat, corn and cotton, so we may picture the development of aquatic farming, where even now hand labor is being replaced by machinery, and by more efficient methods of distribution. The great problem is how best to replace destructive exploitation by constructive methods of increasing production through annual crops.

To this end instruction in economic biology is needed. The federal commissioner, Dr. Smith, has ably pointed out the need of such educational facilities, and until such development can be secured the necessary safeguards for time and capital invested in this work are lacking, and progress must be as of the halt and of the blind.

As a practical matter it is exceedingly difficult for either state or federal departments to draw from a reluctant committee on appropriations money to be used upon projects of which they have no first-hand information and which are exploited by relatively few people. In Massachusetts the problem has resolved itself to a dilemma, whether the fisheries and the shell fisheries shall be maintained from the public treasury and freely open to the public, or whether the fishing rights on the tidal flats shall be leased to individuals and the maintenance and enforcement of the law be provided from the money secured from the leases or licenses and the balance used for reducing the state tax, thus regarding the lands under water and the public fishing rights as a state asset for the benefit of all the people. Consideration of the first proposition clearly leads to the result that if the community plants and cares for the annual crops for the benefit of the fishermen, why should it not do the same for the farmer? And just as the communistic growing of corn and potatoes has proved an economic failure, so must appropriations of money by the town or county for planting clams to be turned into cash by a few people whose interests or necessities impel, be futile unless it is frankly regarded as eleemosynary. The history of nations and of the ages proves that for increased production individual initiative and responsibility is necessary, and the time is not far distant when we must revise our practises and our laws so that all the suitable land below high-water mark may be utilized. No longer will obtain the anomalous condition where, as in Maine, Massachusetts, Rhode Island and other states, oysters may be artificially propagated, but not all other varieties of food and bait mollusks. The several state governments and the federal Bureau of Fisheries are now taking up the plan advocated in 1892, which evoked little response in this country, but which was reprinted in English and German current publications, wherein the writer advocated these practises and pointed out the similarity between the possibilities of agriculture and aquiculture for increasing the yield of food per acre.

It is a deplorable characteristic of human psychology that it is relatively easy to interest people in what is readily seen. The propagation of aquatic forms must overcome the handicap of lack of popular knowledge of the processes involved. It is comparatively simple to secure money to raise black foxes, denatured skunks, or guinea-pigs; but it is still difficult to interest people in commercial utilization of waters for growing fish and shell fish. Our methods of disposal of sewage and waste have militated against this type of investment and development of potentialities. Those who have been accustomed to exploit free goods and still scent opportunities for personal gain at public cost, have learned methods of putting pressure upon public officials and there are relatively few state or federal departments which are not to some extent hampered by some degree of political, personal or local pressure. The situation in Massachusetts is peculiar in that the town is still a dominant community unit, and town and county politicians recognize the advantage of political manipulation of such public assets as

the fisheries, and are loath to promote any development which is likely to curtail their opportunities for personal influence. It is most encouraging to see evidence that the federal departments are each year becoming less dominated by personal and party politics, and that the officials are permitted to follow the facts wherever they may lead, and to apply the possible corrections. So long as this obtains it is the duty of every organization and right-minded individual to support the federal and state authorities in their attempts to administer these assets for the public good.

Many thinking persons view with alarm the increasing tendency to substitute bureaucracy for democracy and state or federal control or regulation made necessary by changing conditions. The danger lies not so much in the form as in the facts. If the bureaus cease to be the real representatives of the demos, and instead of representing the whole people on the firm basis of judicially ascertained facts, their opinions and acts are coerced and warped from the truth by either subjective or objective considerations, so that they no longer represent the federal democratic ideals, but merely localities and special interests, bending to political and transient expediencies, the danger is not only threatening but is already *here*. The remedy is plain. It is in the hands of the people and must be speedily applied.

G. W. FIELD

GRANTS FOR SCIENTIFIC RESEARCH

(*Continued from p. 57*)

CHIEFLY COLLEGIATE INSTITUTIONS

THE following schedule embodies information obtained regarding research funds held chiefly by universities and collegiate institutions. With some marked exceptions these funds are available for use only under the immediate direction of the institution possessing the fund and by those connected with it either as members of the staff of instruction or as holding a fellowship. Funds devoted to agriculture and the mechanic arts, as for example those created by the federal government, it has seemed best to reserve for separate treatment later and more fully than is possible at present. The same is true with regard to funds devoted to astronomical research. Also information has yet to be received regarding marine biological laboratories. Consideration of the appropriations made by Congress for the support of the "Scientific Bureaus" of the United States would seem to come more particularly within the scope of consideration of another sub-committee.

The data already published regarding research funds for scientific purposes which are of general availability throughout the country, and of medical research funds have been gathered from replies to a circular letter issued by the Subcommittee on Research Funds in the spring of 1915, which asked the question:

> Will you be so kind as to inform me whether the institution with which you are connected possesses any research fund and if so what is its amount and for what purposes and under what conditions is it available.

The letter referred to was sent to such institutions as seemed likely to possess funds of this character, the publications "Minerva" and "Who's Who in Science (International)" serving as guides. It was widely distributed among collegiate institutions. Upon the replies received from these last the statements here presented are based.

University of Michigan, Ann Arbor, Mich. Harry Burns Hutchins, President. Three research assistantships have been established to aid researches of designated professors.

University of California, Berkeley, Calif. Benjamin Ide Wheeler, President. Research in general maintained by appropriations from the university funds. There is a considerable endowment for graduate fellowships. Appropriations for scientific publications are made from general funds, in 1916–17, $30,000.

California Museum of Vertebrate Zoology. Supported by annual gift from Miss Annie M. Alexander, of $7,500.

Scripps Institution for Biological Research, located at La Jolla. Wm. E. Ritter, Scientific Director. Supported by annual gift of $10,500 from Miss Ellen B. Scripps for which an endowment is pledged, and annual appropriation of $12,500 from state.

Massachusetts Institute of Technology, Boston, Mass. Richard C. Maclaurin, President.

Ellen H. Richards Fund. $16,250. For research in chemistry.

Charlotte B. Richardson Fund. $33,379. For research in industrial chemistry.

Whitney Fund. $26,890. For research in seismology.

Samuel Cabot Fund. $55,190. For equipment in industrial chemistry.

For research in sanitary science, the institute has received annually for many years a gift of $5,000–$6,000.

For researches in electrical engineering a gift from the American Telephone & Telegraph Co. per annum for a period of five years from 1913, $15,000.

The institute makes regularly an appropriation from its general funds for research in physical chemistry.

Harvard University, Cambridge, Mass. A. Lawrence Lowell, President.

Jefferson Physical Laboratory. Income from Coolidge Fund (1914–15), $2,700. Joseph Lovering Fund for physical research, $7,720. Ernest B. Dane Fund, available in part for research in physics, $50,000.

Department of Chemistry. Income from C. M. Warren Fund (1913–14). $334.

Gray Herbarium. Remainder of income from endowment of $300,000 not needed to care for collections is chiefly devoted to furthering research.

Peabody Museum. Peabody Foundation Fund. $45,000. Income used for collection and research in archeology and ethnology with special reference to the aboriginal American races.

Huntington-Frothingham-Wolcott Fund. $20,000. Income devoted to archeological and ethnological research and exploration and publication.

Henry C. Warren Fund. $10,000. For carrying on exploration. Principal and interest to be used at the discretion of the corporation.

Mary Hemenway Fund for Archeology. $45,000. Income available for original research in archeology.

The following research fellowships are awarded annually in the Peabody Museum.

Thaw Fellowship. $1,140 per annum. For "work and research relating to the Indian race of America or other ethnological and archeological investigations."

Hemenway Fellowship. $575 per annum. For the study of American archeology and ethnology.

Winthrop Scholarship. $275 per annum. For the study of archeology and ethnology.

Fellowship in Central American Archeology. $600 per annum. For the study of this subject.

Harvard Fellowship in the International School of American archeology and ethnology, Mexico City. $600 per annum.

Department of Geology. Shaler Memorial Fund. $30,367. For original research in geology in the broadest sense, including paleontology, mineralogy, economic geology, etc. The persons nominated for such research are not necessarily officers or students of Harvard University.

Secondary Enrichment Fund. $50,000. Subscribed mainly by American Copper Companies for investigation regarding secondary enrichment of copper ores in the United States, Alaska and Mexico.

Frederick Sheldon Fund for Traveling Fellowships. $396,157. Applicable to the aid of students of Harvard University in further study or investigation "either in this country—outside Harvard University—or abroad."

University of Iowa, Iowa City, Iowa. Carl E. Seashore, Dean. The University possesses a fund of $16,000, about half of the income from which may be used in emergency for research.

University of Wisconsin, Madison, Wis. C. R. Van Hise, President. Usual appropriation in college of engineering for specific research work $5,000 per annum.

Wesleyan University, Middletown, Conn. Wm. Arnold Shanklin, President.

Crawford Memorial Fund. $5,000. Available for purchase of apparatus and promotion of research in physics.

Amos Jay Given Biological Fund. $25,000. Available for maintenance of the department of biology and for the promotion of research in that subject.

University of Minnesota, Minneapolis, Minn. George E. Vincent, President. Funds for research and publication, $10,000 annually, divided as exigencies may dictate.

McGill University, Montreal, Canada. William Peterson, Principal.

Research Fellowships in Mining. $10,000.

Research Fund in Metallurgy. $7,500.

Research work chiefly carried on by annual appropriation.

Rutgers College, New Brunswick, N. J. W. H. S. Demarest, President. Agricultural Research

Fellowships of limited duration have been established as follows:

Sulphur Research Fellowship in plant pathology. $1,000 per annum for three years; expires 1916. Established by the Union Sulphur Co., of N. Y.

Pulverized Limestone Research Fellowship. $600 per annum for three years; expires 1917. Established by Thomas A. Edison.

Potash Research Fellowship. $1,000 per annum for three years; expires 1917. Established by German Kali Works.

Sodium Nitrate Research Fellowship. $700 approximately per annum for three years; expires 1917. Established by the Nitrate Propaganda.

The Amo-Phos Research Fellowship. $600 per annum for three years; expires 1918. Established by the American Cyanamide Co., Buffalo.

The Soy Bean Research Fellowship. $600 per annum for three years; expires 1918. Established by the Murphy Varnish Co., Newark.

New Jersey Zinc Company Fellowship. $1,000 per annum for three years; expires 1919.

Yale University, New Haven, Conn. Arthur T. Hadley, President.

Dana Fund. $24,000 (ultimately). Available for original investigation in geology.

Hadley University Fund. $1,030. Available for research in general.

Elias Loomis University Fund. $314,000. Available for payment of salaries of astronomical observers and the cost of reducing and publishing observations.

Seessel University Fellowship Fund. $43,500. Available for original research in biological studies.

Hepsa Ely Silliman Fund. $85,000. Applicable to a certain extent for scientific research.

Sloane University Fund. $50,000. Applicable to the payment of research assistants in the Sloane Laboratory of Physics.

Sloane Laboratory Fund. $75,000. Income used for the promotion of research and study in physics.

Thomas C. Sloane Fund. $75,000. Available for the study of physics in the Sloane Physical Laboratory.

Russell H. Chittenden Fund. $4,000. Available for research in physiological chemistry.

American Museum of Natural History, New York. Henry F. Osborn, President.

Jesup Fund. $1,000,000. To promote research, exploration and publication.

Morris K. Jesup Fund. $5,000,000. Bequest for purposes similar to preceding fund. Not yet available.

Columbia University, New York, N. Y. Nicholas Murray Butler, President.

Adams Fund. $50,000. Available for the support of a research fellow in physical science and for the publication of the results of his investigations.

Dyckman Fund. $10,000. Available for research in biology.

Peters Fund for Engineering Research. $50,000. Available for research in the department of civil engineering.

Throop College of Technology, Pasadena, Calif. James A. B. Scherer, President. $10,000 per annum guaranteed for maintenance of a department of chemical research. $10,000 given for equipment of same.

Princeton University, Princeton, N. J. John G. Hibben, President. Departmental Fund yielding about $9,000 per annum. Available in part for research.

Brown University, Providence, R. I. William H. P. Faunce, President. Research Fellowships have been founded as follows:

Grand Army of the Republic Fellowships, $10,000. Applicable to advanced liberal study.

Arnold Biological Fellowships. $10,000. Applicable to biological research.

Morgan Edwards Fellowship. $10,000. Applicable to original research in any department of knowledge.

University of Utah, Salt Lake City, Utah. J. T. Kingsbury, President. Fund for research in School of Mines. $7,500. Also some departmental funds for research.

University of Toronto, Toronto, Ontario. Robert Falconer, President. Exhibition of 1857 Scholarship for Scientific Research, awarded biennially £150.

Rensselaer Polytechnic Institute, Troy, N. Y. Palmer C. Ricketts, Director. Louis E. Laflin Research Fund. $10,000. Appropriations for research also made from general funds.

University of Illinois, Urbana, Ill. Edmund J. James, President. Trustees assign amount of general appropriation from legislature which shall be devoted to research. Graduate School appropriation about $60,000 per annum.

Clark University, Worcester, Mass. G. Stanley Hall, President. Smith-Battles Fund for Psychological Research. $5,000.

It will be obvious from the preceding data that the number of university research funds and especially of permanent endowments is small, and that several of our universities which are distinguished for the amount and the excellence of the scientific papers emanating from them do not possess such funds, so that by far the greater amount of scientific research which is carried on in this country is sustained by special appropriations. And, furthermore, much of the research work pursued in institutions possessing research funds is also sustained by such budget and special appropriations.

In many of the replies received by the committee attention is called to the fact that while there is no endowment for research yet appropriations sometimes large in amount are regularly made for the purpose. The following abstracts of certain of these replies, although lying somewhat outside of the immediate scope of the inquiry made, will be of interest.

Ohio State University: several graduate fellowships established requiring research work. Johns Hopkins University: besides appropriations for research made in budget for each department, income of various funds is drawn upon for purposes of research. Bowdoin College: maintains a table at the Marine Biological Laboratory at Woods Hole. University of Chicago: special appropriations for research made from time to time from the general funds of the university. Field Museum of Natural History: appropriations for surveys, investigation, etc., made from general fund. University of North Dakota: $700 annually from departmental appropriations used for research. Denison University: annual appropriation, $500, made for publication of research work done in the university. Dartmouth College: besides general departmental appropriation in budget, special appropriations for research are made from time to time. Drexel Institute: pays in part fees for professors engaged in investigation. Cornell University: besides appropriations in budget, the university sometimes releases a professor from teaching in order to carry on research. University of Kansas: $8,000 available for fellowships. Mellon Institute of Industrial Research: expenses of researches met by private subscription. Leland Stanford Junior University: appropriations for research made from budget. Pennsylvania State College School of Engineering: expended for research, 1915–16, $1,549. Rose Polytechnic Institute: research work provided for by special appropriation. University of Arizona: will probably receive $5,000 from the state for research in mining. Tufts College: department of biology maintains a room at Harpswell Laboratory. Wellesley College: occasionally an appropriation is made for research carried on by a professor on leave of absence. University of Manitoba: sum of $1,000 has been collected for research in physiology. Worcester Polytechnic Institute: part of annual appropriation spent for research.

The data which the committee has gathered regarding research funds, while fulfilling the ends which it was intended to reach, can not furnish any definite idea of the real amount expended annually in this country in aid of the progress of scientific research. Such information is very desirable, but to obtain it will require a much more extended inquiry than the present one.

While much care has been exercised in the compilation of the foregoing matter, there will doubtless be found errors both of omission and of statement. The undersigned will be glad to receive corrections of such and to insert them later.

Charles R. Cross,
Chairman

KARL SCHWARZSCHILD

The American friends of Professor Schwarzschild hoped that the report of his death was a mistake, but since its confirmation by private letters from Germany, they have felt a great sense of sorrow and loss, not only to science, but to themselves personally. Schwarzschild made a visit to this country in 1910, attending the meeting of the Astronomical and Astrophysical Society of America at the Harvard College Observatory and the meeting of the Solar Union at Pasadena. This visit gave an opportunity for closer acquaintance which ripened into personal friendship, and increased our admiration for the man as well as for the astronomer.

Schwarzschild was born at Frankfort-on-the Main, 1873, October 9. His first astronomical work was done as assistant at the von Kuffner Observatory in Vienna from 1896 to 1899. This work appeared in volume five of the pub-

lications of the von Kuffner Observatory entitled *B*, "Die Bestimmung von Sternhelligkeiten aus Extrafocalen Photographischen Aufnahmen," *C*, "Beiträge zur Photographischen Photometrie der Gestirne." This was pioneer work in the use of extrafocal images, in that it was brought to a successful outcome and applied to various regions of the sky. The Director de Ball published a very appreciative description of Schwarzschild's work in the *Bulletin Astronomique* for 1905.

From 1899 to 1901 Schwarzschild was "privatdocent" at the University in Munich, and in 1901 was called to the University of Göttingen as director of the observatory and professor of astronomy. He held this position for eight years, which were rich in astronomical results, both theoretical and practical. The theoretical work appeared in parts 9–11 of the "Astronomische Mittheilungen der Königlichen Sternwarte zu Göttingen." Perhaps the most interesting part relates to the improvement of the reflecting telescope by a combination of curves of the two mirrors which would give a field as flat as the refractor used for the "Astrographic Chart."

The practical part of the work at Göttingen included an improvement on the method of extra-focal images which had been used at Vienna. This consisted in giving a motion to the plate during the exposure, so that the image (itself in focus) was built up into a square area sufficiently large to be measured as an extra-focal image. This attachment was called the "Schraffierkassette," and there resulted from its use the "Göttingen Aktinometrie," which covered the zone 0° to + 20° declination. This appeared as part fourteen of the Göttingen publications, and gave the photographic magnitudes of 3,522 stars, also the visual magnitudes as measured at Potsdam by Müller and Kempf.

About this time Schwarzschild suggested the use of the difference between the photographic and the visual magnitudes as a measure of the color of the stars. He suggested the term "Farbentönung" (color-index), and gave this quantity for each of the stars in the "Aktinometrie." He was also one of the first to apply the color-index to the determination of the temperature of the stars.

During his stay at Göttingen he also devised instruments for determining geographical positions in the navigation of airships. The sextant as modified for this purpose was described in "Zeitschrift für Flugtechnik und Motorluftschiffahrt," 1913.

Schwarzschild was called to succeed Vogel as director of the Astrophysical Observatory at Potsdam in 1909. He brought to this trying position a talent exceptionally ripened for a man only thirty-six years of age, and he filled the position with distinguished success. During his term the astrophysical work at Potsdam was carried forward in a way worthy of its first director and his brilliant staff, and the list of publications bears witness not only to the work of the different astronomers, but also to Schwarzschild's ability as a director. Among Schwarzschild's theoretical contributions during this period may be mentioned his work on the distribution of stars in space.

The remarkable range included in Schwarzschild's work, from the improvement in the sextant to the distribution of stars in space, showed that he combined theoretical and practical ability in an unusual degree, thus fitting him especially for the directorship of a great astrophysical observatory.

Schwarzschild's personality was especially pleasing. He was lacking entirely in that stiff formality which renders so many men in high positions unapproachable. He had a great capacity for friendships, and his admiration for Dyson, the English Astronomer Royal, was very pronounced. What could be finer than the simple statement which he made in regard to Dyson, "We nearly always think alike." Schwarzschild's disposition was not in the least jealous. As an example of this may be mentioned his suggestion to the International Committee, that the magnitudes of the Harvard System should be taken as the international standards, and that the other systems should be reduced to this by the application of suitable corrections.

Schwarzschild was happy in his domestic relations and his home was always open to his

friends without any formality. It will be extremely difficult to fill his place and the sense of loss on account of his early death will be very widespread. J. A. PARKHURST

YERKES OBSERVATORY

REPORT ON INFANTILE PARALYSIS

THE conference committee of pathologists which met in New York City on the invitation of the city authorities has made the following report to Dr. Haven Emerson, commissioner of health.

Having been called to New York at your suggestion, and for the purpose of consulting with you concerning the practical measures employed in dealing with the present epidemic of poliomyelitis, we offer the following statement.

We have spent two days in studying the situation and investigating prevailing conditions.

On Thursday morning we went over with you the history of the origin and spread of the epidemic of this year. We made a careful study of your maps and diagrams showing the number and distribution of cases in the different boroughs of the city. This was followed by a discussion of the methods that have been employed, both here and elsewhere, in attempts to control the spread of the disease.

In the afternoon of the same day we visited Willard Parker Hospital and made a careful inspection of the treatment and care given by the city to the children afflicted with this disease.

Thursday evening we had a discussion concerning the methods being employed and the possibility of making these more efficient.

On Friday morning we visited cases quarantined in their own homes, and in this way were able to compare the hospital care with the home care of the sick. We also made a survey of certain crowded infected districts, and, with a diagnostician, we visited certain homes in which cases have been recently reported.

Friday afternoon we gave to a more formal discussion and the suggestion of definite recommendations.

We have given special attention to the methods now employed by you and your department, and we approve of the measures you have taken.

The weight of opinion favors the view that infantile paralysis is mainly spread through personal contact, and measures have been directed chiefly from this point of view. Cognizance, however, has been given to additional methods of transmission, among which is the bite of insects. For sanitary purposes it is proper to consider that this disease is transmissible directly from the sick to susceptible persons, or indirectly from the sick through carriers.

Even with our incomplete knowledge of the dissemination of the disease, it is evident that, in seeking to abate the epidemic, stress must be especially laid upon two things, as is now being done:

1. The early recognition and notification of the disease, and

2. The immediate isolation of patients and cases of suspicious illness.

Furthermore, on account of incomplete knowledge concerning the disease, measures known to be effective in checking the spread of other infections should be applied and these are, particularly, personal hygiene, cleanliness of person and surroundings, and care of food, which should be thoroughly cooked.

In order to secure the earliest possible recognition and notification of cases and their prompt isolation, we wish to direct particular attention to the appeals that have been made by the department to the physicians of the city and to the public generally that they cooperate with the department in all these measures.

We strongly recommend that you inaugurate a house-to-house inspection of as large a part of the city as is practicable, twice a week, for the purpose of education and of securing the early recognition, notification and isolation of the disease.

We are of the opinion that satisfactory isolation is secured only in hospitals. Moreover, not only is more thorough protection secured for the public by the hospitalization of patients, but it is also better for the individual patient.

There is still much to be learned concerning the period of incubation, accurate methods of early diagnosis in non-paralytic cases, modes of transmission and the length of time persons continue to carry the infection, and, in view of these factors, a scientifically adequate method of control is impossible at the present time.

The committee recommends the closest coöperation possible among the different laboratories and investigators that may enter upon investigation of problems connected with epidemic poliomyelitis.

The committee would suggest the following problems as especially desirable for investigation at this time.

1. Methods of culture of the virus of poliomyelitis, with especial reference to corroboration of previous work, to simplification of methods, and to the distribution of the virus in the body of patients.

2. The immunologic reactions of patients, supposed carriers of the virus, and others.

3. The virulence for animals, of the crude virus, in order to determine if possible whether there are any differences in the virus causing outbreaks in different parts of the country as well as to discover, perchance, more susceptible animals for experimental purposes than are now available.

4. The microscopic study of the secretions of the nose and throat and of the intestinal contents of patients suffering from poliomyelitis, persons who have come in close contact with such patients, and others.

5. The transmission of the disease by insects and domestic animals and other possible modes of transmission.

6. The study of practical methods of disinfection.

SCIENTIFIC NOTES AND NEWS

Dr. William H. Welch sailed from New York on August 6 for England to make studies in connection with the organization of the school of hygiene and public health established by the Rockefeller Foundation at the Johns Hopkins University. Dr. Welch will also study, as president of the National Academy of Sciences, the manner in which England has been organized in scientific lines for the war. He is accompanied by Dr. George Ellery Hale, chairman of the committee of the academy on scientific organization.

The Cartwright Lectures for 1916 of the Association of the Alumni of the College of Physicians and Surgeons, Columbia University, will be given by Dr. Richard M. Pearce, professor of research medicine, University of Pennsylvania, on October 24 and 25. Professor Pearce's subject will be: "The Spleen in its relation to blood destruction and regeneration."

Dr. J. Howard Beard, Urbana, has been appointed health officer of the University of Illinois.

Dr. Gustavus Mann, until last year professor of physiology in Tulane University, has been appointed consulting chemist for the Freeport Oil Company of Texas.

Dr. Donald B. Armstrong has resigned as director of the department of social welfare of the New York Association for Improving the Condition of the Poor, to become assistant secretary and director of the community tuberculosis experiment of the National Association for the Study and Prevention of Tuberculosis.

Dr. Herbert J. Spinden, of the American Museum of Natural History, has been given charge of the archeological survey of Porto Rico undertaken by the New York Academy of Sciences, and has been in the field. In the early part of the season he visited Venezuela for a preliminary archeological reconnaissance.

Professor A. L. Kroeber, of the University of California, has returned to Zuñi for further investigation of their social and ceremonial organization.

Dr. James J. Mills, instructor of ophthalmology at the Johns Hopkins Medical School, has sailed for France, where at Biarritz he will assist in the treatment of injuries to the eyes of the soldiers.

The Antarctic relief ship *Discovery*, which has been placed at the disposal of the British Admiralty for use in the effort to rescue the

marooned men of Sir Ernest Shackleton's expedition on Elephant Island, sailed from Plymouth Sound on August 10, for Port Stanley, Falkland Islands. Sir Ernest will embark at that port in another effort to reach Elephant Island.

M. Henry Nocq has been commissioned to prepare a portrait plaque of the French archeologist and anthropologist, M. Joseph Déchelette, who has been killed in the war. Subscriptions may be sent to M. le Comte O. Costa de Beauregard, Sainte-Foy, par Longueville (Seine-Inférieure). Those sending a subscription of 10 francs are entitled to a replica of the plaque in bronze, those giving 50 francs to one in silver.

Dr. John Benjamin Murphy, the distinguished surgeon, professor of surgery in Northwestern University, died on August 11, aged fifty-nine years.

Dr. Bushell Anningson, lecturer in modical jurisprudence in the University of Cambridge since 1884, has died at the age of seventy-eight years.

Edgar Albert Smith, an authority on conchology, from 1867 to his retirement in 1913 on the scientific staff of the British Museum, died on July 22, aged sixty-nine years.

The death is announced of Dr. R. C. Delgado, of Havana, member of the Cuban Board of Health and secretary of the Havana Academy of Sciences.

The Swedish government has decided to postpone until July 1, 1917, the distribution of the Nobel prizes in physics, chemistry, medicine and literature.

The Paris Academy of Medicine, following the precedents of 1914 and 1915, has decided not to suspend its sittings this year. It will continue to meet during the months of August and September for the discussion of questions relating to public health and national defence.

Mr. Richard T. Crane, in a telegram to Mayor Mitchel, of New York, announces a gift of $25,000 to the individual who may offer the best cure for infantile paralysis, or the best solution to that problem, within a year.

The Senate Public Health Committee, on July 28, voted to report favorably a proposed appropriation of $2,000,000 to be spent in the care of indigent sufferers from tuberculosis. The object of the appropriation is to relieve the states of the care of invalids who leave their homes in search of health and then become charges on other communities.

The United States Public Health Service has inaugurated a campaign for the relief of sufferers from hay-fever. The service will endeavor to have state legislatures enact laws to provide means for fighting weeds which are known to provoke the disease. It is said that 2 per cent. of the people of the United States are sufferers from hay-fever.

Nature quotes from the June number of the *Bul. Imp. Acad. Sci.*, Petrograd, the statement of plans to establish a biological station on Lake Baikal. The largest of the fresh-water lakes of Europe and Asia, and said to be the deepest in the world, it possesses a fauna in many respects unique. Some of its fishes are found nowhere else, and some live at a greater depth than any other fresh-water fishes. Among them are very ancient forms, and, according to some investigators, vestiges of the Upper Tertiary and subtropical fauna of Siberia and, possibly, of central Asia. Though Lake Baikal has long since attracted the attention of Russian zoologists, much remains to be done, and it is felt that private research, valuable as its achievements have been, should be supplemented by a fully equipped biological station, which alone can cope with the problems involved in a thorough and systematic investigation. The subject has been mooted for some time past in Russian scientific circles and is now brought within measurable distance of realization by a donation of £1,600 received from a Siberian gentleman, Mr. A. Vtorov, and the academy has appointed a commission to take immediate steps to give concrete form to a project destined to be of great importance for biological science.

Preliminary steps have been taken by the War Department toward the formation of a Reserve Corps of Engineers for the army, as provided by the National Defense Act of June 3 last. By direction of the chief of engineers letters were sent to-day by Lieutenant Colonel E. Eveleth Winslow, of the Army Engineer Corps, to all the district engineer officers of the army throughout the country, paving the way for the creation of these new reserve corps, which will be composed of officers to be commissioned from among the engineers of the country and of an enlisted reserve corps of engineers. The plan for the formation of the new Reserve Corps is set forth in Lieutenant Colonel Winslow's letter as follows: "The importance of engineers in time of war is now universally recognized, and during the past few months steps have been taken to arouse the interest of the engineering profession in the national defense. Congress has now provided a means by which the civil engineers can more fully prepare themselves for that highest duty of citizens—the defense of our country. An engineer section of officers and enlisted reserve corps has been authorized, and in the opinion of the chief of engineers there is for the officers of the Corps of Engineers no more important duty than their active assistance in making a success of the new corps. All the engineers in the country should be informed of the existence of this new corps and those possessing the necessary qualifications should be enrolled as its members. A close cooperation between our engineer officers and the civilian engineers is therefore necessary, and fortunately the first steps in such cooperation have been already taken by the action of some of the most important of the engineering societies in indorsing the campaign for preparedness and in urging upon Congress the passage of the Officers' Reserve Corps law.

The Senate Committee on Public Health and National Quarantine has reported favorably the bill to promote the efficiency of the United States Public Health Service. The bill has already passed the House of Representatives. The bill limits, according to the *Journal* of the American Medical Association, the appointment of the surgeon-general of the Public Health Service to commissioned officers in the service, not lower in grade than surgeon, and require that the surgeon-general at the expiration of his four-year term of office be carried as an extra number in the grade of assistant surgeon-general, unless he be reappointed. As an inducement to physicians to enter the service, the bill provides for the promotion of assistant surgeons to the next higher grade after three years' service, instead of after four years as at present. The chiefs of the bureaus of zoology, pharmacology and chemistry in the hygienic laboratory, are to be commissioned by the president, by and with the advice and consent of the Senate, as professors of zoology, pharmacology and chemistry, respectively, and are to be entitled to leaves of absence as now provided by law for commissioned medical officers. Provision is made for the appointment of five additional professors, qualified for special work in sanitary engineering, epidemiology, pathology, anatomy, bacteriology, housing, or other matters that relate to the propagation and spread of disease. Men of this class, the committee's report says, often do not have medical degrees, and under the present system of commissioned service only doctors of medicine are provided for; and the bill will remove this defect and make places for men who are specially trained in these highly technical fields, but who are not graduates in medicine.

UNIVERSITY AND EDUCATIONAL NEWS

Lafayette College is the residuary legatee of Albert N. Seip, of Washington, D. C., a member of the class of 1862. It is said that the college will ultimately receive not less than $250,000.

Dr. Robert Bennett Bean, now professor of gross anatomy at Tulane University, has been appointed professor of anatomy at the University of Virginia, to take charge of the courses in gross anatomy and neurology formerly given by the late Dr. Richard H. Whitehead.

Dr. R. M. Strong has resigned the chair of anatomy at the University of Mississippi to accept the position of associate professor of anatomy in the medical school of Vanderbilt University, Nashville, Tenn.

The following appointments to the faculty of the University and Bellevue Hospital Medical College have been announced: Dr. William C. Lusk, professor of surgery; Dr. Joseph B. Bissell, Dr. Thomas A. Smith, and Dr. Arthur M. Wright, clinical professors of surgery; Dr. W. Howard Barber, chief of clinic, department of surgery; Dr. George Francis Cahill, instructor in surgery; Dr. Theodore J. Abbott, clinical professor of medicine; Dr. Benjamin M. Levine, clinical professor of cancer research; Dr. Charles Krumwiede, Jr., assistant professor of bacteriology and hygiene; Miss Mary Smeeton, instructor in bacteriology.

Promotions in the philosophical and engineering faculties of the Johns Hopkins University has been made as follows: Knight Dunlap, professor of experimental psychology; Joseph C. W. Frazer, professor of analytical chemistry; E. Emmet Reid, professor of organic chemistry; Grandville R. Jones, associate professor of civil engineering; Paul B. Davis, associate in chemistry; William B. Kouwenhoven, associate in electrical engineering.

DISCUSSION AND CORRESPONDENCE

CULTURE MEDIA FOR PARAMECIA AND EUGLENA

A communication to this journal by J. B. Parker, entitled "A Method of Maintaining a Supply of Protozoa for Laboratory Use,"[1] brought to my mind a culture medium which I used at the University of Chicago for a few years and found thoroughly reliable. The method was given to me by one of my assistants at the time, Mr. John G. Sinclair, who according to my recollection had obtained it from Dr. A. W. Peters, of the University of Illinois.

Enough wheat to make about one half gram per liter of the culture solution is boiled in a small quantity of water for a few minutes. (The original method as given to me called for cracked wheat, but I obtained good results with whole wheat.) The boiled wheat is then placed in tap water in the ratio indicated above, and the solution is inoculated either from some culture of paramecia already on hand or with pond water. In most cases, I used water taken from the immediate vicinity of submerged pond vegetation. It was my custom to use large battery jars for the culture media, which were placed with glass covers on a table in the room where the paramecia were to be used. In the course of a week or so, depending upon the room temperature, I was always able to obtain an abundance of large paramecia.

A method for *Euglena* was also given to me, but I never used it, having no occasion to need this protozoan. I presume the method is equally good. One half gram of rice per liter of culture solution is washed thoroughly and drained. The washed rice is then boiled for about five minutes and put into tap water. After inoculation, the solution is placed where it may obtain direct sunlight.

The directions also state that it is advisable to add about one fourth gram of boiled grain (rice or wheat according to the culture) per liter of the medium, every three weeks and also just before use by a class begins. Furthermore, it is desirable to stir the solution every few days for an oxygen supply.

R. M. Strong

[1] Science, November 19, 1915, p. 727.

SEVERE RESTRICTIONS TO NORMAL GEOGRAPHIC CYCLE

The formulation of the conception that there is a distinct cycle of corrasive development through which all land-forms must pass is now generally recognized to be one of the first half-dozen brilliant achievements in geologic science of the century just closed. Like many broad generalizations, this one is, upon critical submission to quantitative measurement, found to be too sweeping in its character. Close inspection soon discovers that there are grave complications in the normal scheme. Already the latter has to be especially adapted to fit, on the one hand, condi-

tions of glacial climate, and, on the other hand, conditions of arid climate.

Limitations to the normal geographic cycle are even more severe than these bare statements intimate. If the United States, for instance, be divided into three north and south belts of subequal size one of the divisional lines coincides with the course of the Mississippi River; and the other with the line of the Rocky Mountain front. The belts are each approximately one thousand miles in width.

In the easternmost of these belts the forces of normal landscape sculpturing are most active. The rivers at the present time are wearing down the mountains and hills towards base-level about as rapidly as is done anywhere else on the face of the globe, and about as fast as it is ever done.

In the central belt, the tract lying between the Great River and the Rocky cordillera, the streams traversing the region are far from doing normal corrasive work or of producing net results. Between the Canadian and Mexican boundaries, a distance of more than 2,000 miles, only five streams leave the Rocky Mountain front, and four of these are quite inconsiderable. They can have relatively little influence in the effort to base-level so vast a region as the Great Plains. Dust and sands from western deserts are constantly exported to this region. In fact, lying on the leeward side of the arid lands the Great Plains country is a chief area of wind-laid depositions. The continental deposits over much of the region are more than 1,000 feet thick, a fact amply attesting the prodigious extent and the unusual rapidity of their formation. This circumstance alone explains the excessively slow rate of continental denudation which the recent government stream-measurements of the Mississippi River give. The normal geographic cycle does not obtain in this region.

In the westernmost belt the general lowering and leveling effects of rivers are inappreciable. Water-work is reduced to its lowest terms. Wind is the mastering erosive agency. The geographic cycle has for its dominant element wind-scour instead of stream-corrasion.

The idea has a still broader bearing. It has world-wide application. According to the late Sir John Murray more than one fifth of the entire land surface of the globe is desert. Another one fifth and more is little affected by normal river corrasion. Still another one fifth of the land surface is, or at least was until very recent geologic times, as truly desert as is the Sahara to-day. Of all the world's land area, therefore, fully two thirds are not subject to normal stream-work; and the normal geographic cycle is without verity.

CHARLES KEYES

UGO SCHIFF

IN SCIENCE, June 30, 1916, page 922, Professor Wm. McPherson, in his obituary notice of Ugo Schiff, says:

> This recalls the fact also that Professor Baeyer's laboratory at Munich did not include any laboratory devoted to physical chemistry until 1913, when a small room was fitted up for this work.

Professor McPherson is mistaken. During a number of years before and after 1887, Krüss gave, in Baeyer's laboratory, courses of lectures and laboratory work in physical chemistry. The complete courses ran through several semesters and the experimental exercises were given in a room specially fitted. They included density determinations of solids, liquids and gases, by various methods, cryoscopic molecular weights, spectroscopic work (emission and absorption), optical rotation, etc. Probably no better courses were given anywhere, at that time, outside Ostwald's laboratory. It may well be that Krüss's premature death caused the courses to be discontinued.

J. BISHOP TINGLE

MCMASTER UNIVERSITY,
TORONTO, CANADA.

SCIENTIFIC BOOKS

The Origin of the Earth. By THOMAS CHROWDER CHAMBERLIN, head of the Department of Geology, The University of Chicago. The University of Chicago Press, 1916. Pp. x + 271. (The University of Chicago Science Series.)

This book, by the distinguished author of the planetesimal hypothesis, is one which has

long been desired by geologists as well as other scientists. The method of treatment conforms to that followed by the University of Chicago Science Series. This requires that the subject shall be presented "in as summary a manner and with as little technical detail as is consistent with sound method. These volumes will be written not only for the specialist, but for the educated layman."

The previous publications on the planetesimal hypothesis and its relations to the origin of the earth are found in articles chiefly by Chamberlin in the *Journal of Geology,* chiefly by Moulton in the *Astro-Physical Journal* and by various collaborators, mostly in publications of the Carnegie Institution; but only the specialist has pursued all of this more or less technical literature to its lairs. In addition, Moulton has given some account of the astronomic aspects of the hypothesis in his text-book of astronomy and Chamberlin and Salisbury in 1906 have given considerable space to the subject in their "Geology," especially the first eighty pages of Volume II. These are works which are not readily accessible to the educated layman. Furthermore, the present volume by going straight to its end and omitting technicalities brings the essential framework of the hypothesis into better relief and perspective than is the case in Chamberlin and Salisbury's "Geology." Published ten years after the latter, it furthermore takes advantage of the research of a later decade. There is added also an essentially new chapter on "The Juvenile Shaping of the Earth."

The form of presentation is very readable and attractive. It follows largely the intellectual trail which led the author, as he says, a specialist in glacial geology, "across the pass that leads from the land of rocks into the realm of cosmogonic bogs and fens. Its mists were already gathering over the path ahead. Strangely enough, the cold trail of the ice invasion had led by this long and devious path into the nebulous field of genesis."

All older views of the origin of the earth had grown up around the idea that the matter which constitutes the planets was a residuum left from the primal gathering in of the solar nebula. This process had been given concrete form in the nebular hypothesis of Laplace. But an examination of the stubborn facts expressed in the structure and motions of the solar system brought out dynamical inconsistencies with the terms of the nebular hypothesis. Modified forms of that hypothesis could not overcome the objections. Therefore Chamberlin was led to build up an hypothesis of earth origin from a totally different beginning. He postulated an ancestral sun already condensed and sought to derive the planetary matter and planetary energies of motion from the expulsive forces set up by the close approach and passage of another star. The result was the development of a great swarm of larger and smaller particles revolving independently but nearly in one plane in elliptic orbits about the sun. This is the basal foundation of the planetesimal hypothesis. In these respects it is in direct opposition to the Laplacian hypothesis and in considerable opposition to the meteoritic modifications from that hypothesis.

The subject is vast and the evidence on many aspects is somewhat vague. A variety of subhypotheses could be raised for comparison with those which are linked together by the author to make a consistent whole. This would lead so far afield, however, that this review will be held rather closely to a presentation of the vital points in each chapter, thus placing stress on a summary of the arguments of the ten chapters rather than on an analysis of their bases upon which they rest.

The first chapter is on the Gaseous Theory of Earth-Genesis in the Light of the Kinetic Theory of Gases. The spheroids of gravitational control of the planets are considered, the minimum radius of the earth's being about 1,000,000 kilometers. The relation of the mass of the planet to its power to retain an atmosphere is the next thesis. Beyond that zone of atmosphere which is dense enough to obey the kinetic law of gases, but within the outer limits of the spheroid of control, must lie an ultra-atmosphere divided into two zones. The lower of these is characterized by fairly free molecules driven upward from below by the impacts

of other molecules and curving back again under the pull of the earth's gravitation into the denser atmosphere. The action is like that of particles of water splashing back in a fountain or like the spray from an effervescing liquid. This attenuated zone in which the molecules describe appreciably curved paths between molecular collisions is named the Krenal atmosphere. Beyond it, but still within the spheroid of control, must lie a zone which has come to be inhabited by molecules moving in elliptic orbits in every direction about the earth and moving with considerable freedom from impact. This Chamberlin names the orbital atmosphere. He shows how the several atmospheres are related, giving and taking molecules, and how the orbital atmosphere of the earth merges into the orbital atmosphere of the sun. Following this constructive argument is a destructive argument, showing how the Laplacian hypothesis fails to meet the requirements of the nature of gases.

This is an illuminating chapter. It shows how, in sweeping up the planetesimal matter, immediate and direct impact with the body of the earth was not necessary. It will be found suggestive also in relation to the later history of the atmosphere. The moon lies far within the zone of the orbital atmosphere and gases given off by the moon during its history would thus be added to the earth rather than diffused into the outer space of the solar orbital atmosphere. As an agent for supplying CO_2 to the earth's atmosphere during times of quiescence of terrestrial igneous activity this may possibly be a factor not to be wholly ignored, though always small.

Chapter II. is on Vestiges of Cosmogonic States and Their Significance. In the structure of the solar system and in the nature of the earth is an autobiography of genesis. These are the material records, but equally if not more important, Chamberlin points out, are the dynamic records. In rotations, revolutions, and other relations are found automatic vestiges of creation; difficult to interpret, perhaps, but rigorously definite if we but understood their evidence. The dynamic vestiges in the sun are found first, in the inclination of its plane of rotation to the mean plane of the planetary orbits; second, in the enormous preponderance of mass in the sun, the enormous preponderance of moment of momentum in the planets.

Chapter III. is entitled The Decisive Testimony of Certain Vestiges of the Solar System. By these vestiges the Laplacian hypothesis is tested and found wanting. The less specific hypotheses, including that of Kant, hardly lend themselves to rigorous testing and therefore can not be regarded as working hypotheses.

The following chapter is given the name of Futile Efforts. It records the results of inquiries by the author along other lines than those of the Laplacian hypothesis. These other lines were found also to lead to unsatisfactory results, but they pointed the way to the general direction in which a successful hypothesis must probably lie. Especially they pointed to spiral nebulæ as dynamically more promising forms.

Chapter V. is entitled The Forbidden Field. The direct rotation of the planets about their axes had been thought to forbid any hypothesis which sought to integrate the planets from particles scattered in a zone and in free orbital motion about the sun. This is shown to be true however, as demonstrated by Moulton, for a system of circular orbits only. For elliptical orbits the distribution of matter in the region of growth may readily be such that the concentration into a nucleus would engender a direct rotation. This field of hypothesis is therefore no longer forbidden.

But how shall be produced such a primal state as that postulated in a slowly revolving central sun with but little moment of momentum surrounded by a small amount of orbital matter revolving nearly in a plane, dispersed over wide limits, and possessing a relatively enormous moment of momentum? This problem is taken up in Chapter VI., entitled Dynamic Encounter by Close Approach. The volume of a star represents a balance between expansional and condensational forces acting on a vast body of gaseous nature. On the approach of two stars their mutual gravitation would produce tidal forces diminishing their

self gravitative power along the line between the centers and give the expansive forces opportunity to rise to explosive violence along that line. This tidal force is actually greatest at the centers and would lead to a very deep-seated disruption. The gas bolts shot out would, owing to viscous resistances, be pulsatory, and separated nuclei would therefore be expelled. These nuclei and the associated dispersed matter would, on the nearer side, be dragged sideways after the passing star. On the reverse side the symmetrical tidal protrusions would be left behind, the sun being dragged more than they. The result would be a spiral nebula, a form which would meet the dynamic demands of the existing solar system.

In comment upon this chapter, it should be noted, however, that the innumerable spiral nebulæ of the heavens, although good illustrations of the initial form of the solar system, do not appear to be stages in a similar evolution. They are of a much greater order of magnitude, they avoid the region where the stars are clustered, are at remote stellar distances, and by their very number show a notable duration of their form. On the other hand, the postulated originally spiral form of the solar nebula would have been evanescent. Within a century from the time of origin all except the outer nuclei would have completed many revolutions about the sun. But the different periodic times of the nuclei would in a few revolutions have caused to disappear the initial spiral form. It would become wound up and further blended together owing to the high ellipticities of the constituent orbits.

Having attained this initial state, Chapter VII. deals with the Evolution of the Solar System into the Planetary System. The building up of the planets is believed to have followed three stages: first, the direct condensation of the nuclear knots of the spirals into liquid or solid cores; second, the less direct collection of the outer, or orbital and satellitesimal matter; third, the still slower gathering up of the planetesimal material scattered over the zone between adjacent planets. This third factor in Chamberlin's view is regarded as very important and he believes this diffused matter contributed much of the earth substance, very slowly and in a dust-like form. This is one of the critical points in the details of the theory, unessential to the larger framework, but upon which turns much of the development of the following argument. In earth-growth the denser planetesimal dust, Chamberlin argues, tended to be somewhat segregated into the primitive ocean basins and served to maintain in them, as the earth was built outward, a greater density than in the elevated zones between. It seems a debatable question to the reviewer if such a large proportion of the added material was necessarily dust-like and capable of being distributed by the primitive atmosphere and ocean. Upon the mean size of the incorporated units various subhypotheses of consequences may be built up. In the absence of knowledge Chamberlin's view may be accepted as the most probable, but the problem illustrates the fertile branching which is possible upon the trunk of the planetesimal hypothesis.

Chapter VIII., entitled The Juvenile Shaping of the Earth, occupies sixty-eight pages, more than twice the average length of the chapters. The earth is conceived as beginning to hold an ocean by the time it contained 30 or 40 per cent. of its present mass. From that time atmosphere and hydrosphere transported, sorted and deposited the planetesimal dust, building up the lighter material into protuberant areas, which became the continental platforms. Great importance is attached under the shaping agencies to periodical changes in the rate of rotation. Accompanying a stage of internal condensation, a corresponding speeding up of the rotation would occur and a relative subsidence of the polar areas. Surface compression in high latitudes, surface tension in the torrid zone, would accompany such an increased oblateness of form. The slow accumulation of planetesimals between stages of condensation would, on the other hand, it is thought, produce a checking of rotational velocity and the converse effects in earth-form and in earth-strains. With growth there was thus a rhythmic oscillation in strain. At times when the polar areas were in tension it is

argued that a cracking would occur, giving three yield zones which tended to be at angles of 120 degrees to each other. These radiated from the poles after the analogy of the hexagonal columnar jointing of basaltic columns due to shrinkage in cooling. These yield zones in vertical meridional planes, it is argued, would, again after the analogy of the basaltic columns, be the elevated zones and determine the larger outlines of the initial continents. There would result six great oceanic basins, counting the Mediterranean as one. These oceanic basins are conceived to be the somewhat circular bases of cones of slightly heavier material built up during earth-growth and having their apices deep in the centrosphere. By periodic settling of these heavier master segments the continental yield tracts between are squeezed up and made more protuberant.

This hypothesis of juvenile shaping is of course, like the other steps in the development of the planetesimal hypothesis, dependent upon the basal postulates. It is not clear that earth-strains due to the causes invoked could initiate such a primary segmentation, in fact calculations on the stresses which the reviewer has made to test this sub-hypothesis pointed to quite a different method of yielding. The distribution of continents and oceans does not accord very closely with it, and the evidence of isostasy does not indicate that the density differences between continents and ocean basins reach below the outer fiftieth of the earth's radius. This hypothesis of juvenile shaping should therefore be accepted with much reserve and does not appear to be as well supported as are the conclusions of the previous chapters.

Chapter IX. is on The Inner Reorganization of the Juvenile Earth. The particles of radioactive matter would tend toward local heating and fusion. Thus they would be progressively concentrated into the outer shell of the earth by the rising of igneous matter. Pulsatory stresses from body tides and from shrinkage are regarded as the chief agents leading fused matter outward and serving to maintain the earth's body in solid form.

Chapter X. is on Higher Organization in the Great Contact Horizons. This is a discussion of the conditions which it is thought favored the rise of life on the surface of the globe. The most favorable environment for this great step in protoplasmic synthesis is regarded as being in the soil layer of the land, the contact horizon of earth, water, air and sunlight. The conditions of planetesimal infall and of the lack of devouring cells would have especially favored the process during the later growth stages of the earth.

Having given this summary of the volume, some statements may be made in regard to it as a whole. It must impress every reader as a notable constructive addition to thought upon this fundamental subject. Chamberlin follows his postulates to their logical conclusion, even though this must involve the building of hypothesis upon hypothesis. He wisely considers this preferable to no attempt in the direction of complete solution. But the limits of the book and the nature of the Science Series to which it conforms preclude him from following that method of multiple working hypotheses which he had elsewhere used and the necessity for which he has urged in an article which every scientist should read.[1] This method is especially desirable where there are alternative postulates which have not been disproved. No one realizes more strongly than Chamberlin, however, the preliminary and tentative nature of many of his conclusions, owing to the nature of his postulates.[2]

Because of the submergence of the method of multiple working hypotheses, however, the lay reader and even those geologists who do not go into the literature behind the volume will be apt to obtain too narrow and rigid a conception of the limits of the planetesimal hypothesis. Each section seems so convincing upon a first reading that it may appear as if future work must be built as added stories or as finishings to the present structure; whereas the lower stories appear in fact so broad and

[1] "Studies for Students. The Method of Multiple Working Hypothesis." *Jour. Geol.*, V., 837–848 (1897).

[2] See especially pp. 171 and 223 for his comments.

well founded that there is room for alternative superstructures beside that which Chamberlin here presents.

The previous paragraph has dealt with alternative possibilities; on page 178, however, an erroneous diagram of stress-differences due to the weight of second harmonic inequalities is taken from G. H. Darwin. The original paper was published in 1882. About a year later Charles Chree pointed out an error in Darwin's procedure which led Darwin to publish a correction in 1885. The correct solution is given in Darwin's Scientific Papers, Vol. II., pp. 459–481, 1908. The erroneous diagram indicates a tidal force eight times greater at the center than at the surface. A corrected diagram would show the tidal stress at the poles, on the equator, and at the center in the ratio of one to three and eight. On the equatorial surface the stress due to either tides or to lack of adjustment between oblateness and rotation period is therefore not one eighth but is in reality three eighths of the amount at the center. The maximum stress-difference at the equator is, however, not in a vertical but is in the horizontal plane. There is doubt if tidal stresses could ever have been an effective agent in kneading liquid matter out of the earth's body, since the forces are relatively small and the *pressure gradient* due to that cause is very much smaller still. On the other hand, if the moon were much nearer the earth in primordial times the tidal stresses may have risen to an important magnitude.

But in closing we must not look at this or that detail, nor at this or that chapter. To gain a proper appreciation of the value of the investigations which are condensed in this volume we must compare the present state of thought upon the general subject with that of twenty years ago, before Chamberlin had begun to publish upon the hypotheses of earth genesis. Measured by that perspective this volume is seen to represent an advance in thought on this subject so great that the names of Chamberlin and Moulton must rank high among those scientists who have dealt constructively with that vast, vague and remote problem—the Origin of the Earth. The subject of earth genesis is now fairly on the road to scientific investigation in place of philosophic speculation. JOSEPH BARRELL

PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES

THE seventh number of volume 2 of the *Proceedings of the National Academy of Sciences* contains the following articles:

1. *On the Mobilities of Gas Ions in High Electric Fields:* LEONARD B. LOEB, Ryerson Physical Laboratory, University of Chicago.

The results, though at variance with those of most observers at low pressures for negative ions, are in good agreement with recent results of Wellisch, and likewise lead to the conclusion that the "cluster" theory is no longer tenable.

2. *The Relation of Myelin to the Loss of Water in the Mammalian Nervous System with Advancing Age:* HENRY H. DONALDSON, Wistar Institute of Anatomy and Biology, Philadelphia.

There is no evidence that the cell bodies and their unsheathed axons suffer any significant loss of water; the progressive diminution in the water content of the brain and spinal cord is mainly due to the accumulation of myelin, the formation of which is a function of age, the most active production occurring during the first twentieth of the life span.

3. *Differential Mitoses in the Germ-Cell Cycle of Dineutes nigrior:* R. W. HEGNER AND C. P. RUSSELL, Zoological Laboratory, University of Michigan.

The most conspicuous difference that we have discovered between the origin of the oocyte in *Dineutes nigrior* and in *Dytiscus* is in the number of differential mitoses; in *Dineutes nigrior* there are only three whereas in *Dytiscus* there are four.

4. *Some Minerals from the Fluorite-Barite Vein near Wagon Wheel Gap, Colorado:* ESPER S. LARSON AND ROGER C. WELLS, U. S. Geological Survey, Washington, D. C.

A description of specimens of the unusual mineral gearksutite of a peculiar kaolinite and of a new fluoride-sulphate, creedite.

5. *The Processes taking Place in the Body by which the Number of Erythrocytes per Unit Volume of Blood is increased in acute Experimental Polycythæmia:* PAUL D. LAMSON, Pharmacological Laboratory, Johns Hopkins University.

It is concluded that the liver acts as a reservoir for erythrocytes. The process by which the liver increases the number of the erythrocytes is thought to be a loss of plasma from the liver capillaries together with a constriction of these vessels driving the erythrocytes on into the blood stream.

6. *The Influence of Morphin upon the Elimination of Intravenously Injected Dextrose in Dogs:* I. S. KLEINER AND S. J. MELTZER, Department of Physiology and Pharmacology, Rockefeller Institute for Medical Research.

Morphin increases the elimination through the kidneys of intravenously injected dextrose and retards the return of the sugar content of the blood to its previous level.

7. *The Work of the American Meteor Society in 1914 and 1915:* CHARLES P. OLIVIER, Leander McCormick Observatory, University of Virginia.

From the 5,543 observation of meters, 139 radiants have been deduced with sufficient accuracy to calculate parabolic orbits for the meteor streams they represent.

8. *The Light Excitation by Slow Positive and Neutral Particles:* A. J. DEMPSTER, Ryerson Physical Laboratory, University of Chicago.

Very slow positive rates are still able to excite light with a speed corresponding to less than 5 volts. The neutral rays can also excite light at very slow speeds; the excitation may occur directly because of the collision of a neutral particle with a neutral molecule of the gas.

9. *An Apparent Dependence of the Apex and Velocity of Solar Motion, as determined from Radial Velocities, upon Proper Motion:* C. D. PERRINE, Observatorio Nacional, Argentino, Córdoba.

The position of the solar apex and the solar velocity appear to vary with the proper motion of the stars used in the determination. Such variations point ultimately to some form of rotary or spiral motion among the stars.

10. *Channeled Grating Spectra, obtained in Successive Diffractions:* C. BARUS, Department of Physics, Brown University.

A brief abstract of work presented by the author to the Carnegie Institution of Washington.

11. *The Effect of Parental Alcoholism (and Certain other Drug Intoxications) upon the Progeny in the Domestic Fowl:* RAYMOND PEARL, Biological Laboratory, Maine Agricultural Experiment Station.

Out of 12 different characters for which we have exact quantitative data, the offspring of treated parents taken as a group are superior to offspring of untreated parents in 8 characters. The results with poultry are in *apparent* contradiction to the results of Stockard and others with mammals, but the contradiction is probably only apparent.

12. *The Effectors of Sea-Anemones:* G. H. PARKER, Zoological Laboratory of the Museum of Comparative Zoology at Harvard College.

It seems clear that among the muscles in sea-anemones there are not only independent effectors, and tonus muscles associated with nerve-nets, but neuromuscular combinations that exhibit true reflex action.

13. *Preliminary Evidence of Internal Motion in the Spiral Nebula Messier 101:* A. VAN MAANEN, Mount Wilson Solar Observatory, Carnegie Institution of Washington.

The mean rotational motion is 0.022″ left-handed; the mean radial motion is 0.007″ outward. There is perhaps a small decrease of the rotational motion with increasing distance from the center. The annual rotational component of 0.022″ at the mean distance from the center of 5′ corresponds to a rotational period of 85,000 years.

14. *Symposium on the Exploration of the Pacific—*

(*a*) *The Exploration of the Pacific:* W. M. DAVIS, Department of Geology and Geography, Harvard University.

(*b*) *The Importance of Gravity Observations at Sea on the Pacific:* John F. Hayford, College of Engineering, Northwestern University.

(*c*) *A New Method of Measuring the Acceleration of Gravity at Sea:* Lyman J. Briggs, Bureau of Plant Industry, Washington, D. C.

(*d*) *The Problem of Continental Fracturing and Diastrophism in Oceanica:* Charles Schuchert, Department of Geology, Yale University.

(*e*) *The Petrology of Some South Pacific Islands and its Significance:* Joseph P. Iddings, Brinklow, Maryland.

(*f*) *In Relation to the Extent of Knowledge Concerning the Oceanography of the Pacific:* G. W. Littlehales, U. S. Hydrographic Office, Washington, D. C.

(*g*) *Marine Meteorology and the General Circulation of the Atmosphere:* Charles F. Marvin, U. S. Weather Bureau, Washington, D. C.

(*h*) *On the Distribution of Pacific Invertebrates:* Wm. H. Dall, Smithsonian Institution, Washington, D. C.

(*i*) *The Marine Algae of the Pacific:* W. G. Farlow, Department of Botany, Harvard University.

(*j*) *The Pacific as a Field for Ethnological and Archæological Investigation:* J. Walter Fewkes, Bureau of American Ethnology, Washington, D. C.

(*k*) *Mid-Pacific Land Snail Faunas:* H. A. Pilsbry, Academy of Natural Sciences of Philadelphia.

(*l*) *Some Problems of the Pacific Floras:* Douglas H. Campbell, Department of Botany, Leland Stanford University.

The symposium contains a summary of some of the results obtained in past exploration of the Pacific and an outline of the importance to many sciences of further systematic and continuous exploration of the Pacific.

15. *Nervous Transmission in Sea-Anemones:* G. H. Parker, Zoological Laboratory of the Museum of Comparative Zoology at Harvard College.

There is evidence not only for the assumption of independent receptors, but of relatively independent transmission tracts. A first step in the kind of differentiation so characteristic of the nervous organization in the higher animals.

16. *The Responses of the Tentacles of Sea-Anemones:* G. H. Parker, Zoological Laboratory of the Museum of Comparative Zoology at Harvard College.

The tentacles, in contradistinction to such appendages as those of the arthropods and vertebrates, contain within themselves a complete neuromuscular mechanism by which their responses can be carried out independently of the rest of the animal.

Edwin Bidwell Wilson
Mass. Institute of Technology

SPECIAL ARTICLES

SOIL BACTERIA AND PHOSPHATES

Raw rock phosphate is by far the cheapest source of phosphorus to apply to soils. It consists chiefly of tricalcium phosphate, $Ca_3(PO_4)_2$, which is the most common form of phosphorus in the great natural deposits. This phosphorus compound is relatively insoluble in water, and, for this reason, it has been argued by some that it does not become available to plants; but long-continued field experiments, pot-culture experiments, and farm practise have fully demonstrated that this kind of phosphate does become available for plant growth.[1]

The increased beneficial results obtained by following the practise commonly recommended of intimately mixing decaying organic matter with the phosphate lead to the suggestion that the action of the soil bacteria that decompose organic matter might be an important factor in the solution of the phosphate.

It has been the common teaching that nitrifying bacteria require the presence of a free base, such as lime or an alkaline carbonate, but we have found that the bacterial action produces acid phosphate and proceeds in the presence of this acid salt.

The importance of the action of decomposition products of the active organic matter of

[1] See Circulars 181 and 186, Illinois Agricultural Experiment Station.

the soil on the solubility of phosphates is better understood by a brief consideration of three important and definitely recognized processes that have long been known to bring about the change of the nitrogen from the unavailable form, as it occurs in the protein of clover, manure, etc., to the readily available form of the nitrate.

(1) *Ammonia Production*.—The first process results in the change of the organic nitrogen to ammonia nitrogen. The ammonia is absorbed by the soil moisture and forms ammonium hydroxid. Much carbon dioxid is produced at the same time and some of it, also, is absorbed by the soil moisture and then unites with the ammonia to form ammonium carbonate, which is alkaline.

(2) *Nitrite Production*.—The second and most important of the three stages consists of the oxidation of the ammonia to nitrite by the nitrite bacteria (*Nitrosomonas*). The oxidation of ammonia to nitrous acid by the nitrite bacteria is represented by the following equation:

$$(NH_4)_2CO_3 + 6O = 2HNO_2 + H_2CO_3 + 2H_2O.$$

The ammonium portion of the ammonium carbonate has been converted into nitrous acid and carbonic acid has been set free. Both these acids will combine with some base. It is important to note that nitrogen of the alkaline substance, ammonia, has been converted, or transformed, by the biochemical removal of hydrogen and addition of oxygen into a strongly acid substance, nitrous acid.

The primary purpose of this investigation is expressed in the question, Will the calcium of pure rock phosphate, $Ca_3(PO_4)_2$, suffice as a base; and, if so, will the phosphorus be made soluble? This will be answered by the experimental data reported in another part of this publication.

If nitrite production takes place with tricalcium phosphate as a source of the base calcium, then the reaction must be represented by one of the following equations:

$$Ca_3(PO_4)_2 + 2HNO_2 = Ca_2H_2(PO_4)_2 + Ca(NO_2)_2$$

or

$$Ca_3(PO_4)_2 + 4HNO_2 = CaH_4(PO_4)_2 + 2Ca(NO_2)_2.$$

(3) *Nitrate Production*.—The third and last stage is a simple oxidation of the nitrite to nitrate by the action of nitrate bacteria (*Nitrobacter*). It consists in the addition, by biochemical action, of oxygen to the nitrite:

$$Ca(NO_2)_2 + 2O = Ca(NO_3)_2.$$

This reaction increases neither acidity nor akalinity, and no liberation of insoluble compounds would be expected in this process, as no additional base is necessary, as seen by reference to the equation.[2]

INFLUENCE OF AMMONIA PRODUCTION ON SOLUBILITY OF PHOSPHATES

The most important product formed in the first process, or stage, of the decomposition of organic matter is ammonium carbonate. The ammonium carbonate is alkaline, and consequently could not be expected to exert any action on the solubility of raw rock phosphate.

In 1904 Stalstrom, of Finland, conducted laboratory experiments on the solubility of pure rock phosphates with bacteria which produced ammonium carbonate from peat and from manure containing peat litter. He concluded that there was no appreciable increase in solubility of phosphorus where the bacteria had produced ammonium carbonate over the sterile treatments in which no ammonium carbonate was produced. His experiments lasted forty-two days and were under conditions which would permit of determining soluble phosphorus, were it present. His work is extremely interesting as it demonstrates that in the first stage of decomposition it has been impossible to measure any soluble phosphorus without the growing plant as an indicator.

Similar results have been obtained by the Rhode Island and Wisconsin Experiment Stations in attempts to detect soluble phosphorus in fermenting mixtures of manure and raw

[2] The results of an experiment to test the effect of the nitrate bacteria on pure tricalcium phosphate support the theory that no solution of phosphorus is to be expected by the action of nitrate bacteria.

rock phosphate and in mixtures of soil and raw rock phosphate.

SOLUTION OF PHOSPHATES BY ACTION OF NITRITE BACTERIA

To determine the part played by the nitrite bacteria in dissolving mineral compounds, and particularly raw rock phosphate, was our principal object in these experiments.

One of the authors made the following suggestion several years ago:[3]

In the conversion of sufficient organic nitrogen into nitrate nitrogen for a hundred-bushel crop of corn, the nitric acid, if formed, would be alone sufficient to convert seven times as much insoluble tricalcium phosphate into soluble monocalcium phosphate as would be required to supply the phosphorus for the same crop.

The plan of the experiment, briefly stated, was as follows: A thin layer (about ⅛ inch thick) of a nutrient salt solution was placed in a cone-shaped glass flask of about one liter capacity and about 5 inches in diameter at the bottom. In this solution was placed a definite amount of ammonium salt. The flasks and materials were carefully sterilized. Nitrite bacteria were introduced from pure cultures and sometimes directly from soil. The flasks were plugged with cotton kept at a temperature of 28° C. Many such flasks were prepared, and later, usually at intervals of one week, the contents of two or more flasks were analyzed for nitrogen changed or oxidized and for water-soluble phosphorus and calcium.

In Table I. are shown the relative amounts, by weight, of nitrogen from ammonia sulfate oxidized to nitrite by nitrite bacteria and the amounts of phosphorus and calcium made soluble. Each figure represents the average of duplicate determinations.

EXPLANATION OF RESULTS

The results reported in Table I. demonstrate conclusively that phosphorus and calcium are made soluble while the nitrite bacteria oxidize ammonia nitrogen to nitrite nitrogen. It is also evident that the solubility increases with increasing time of action of the bacteria.

[3] Hopkins, "Soil Fertility and Permanent Agriculture," 197.

TABLE I

Phosphorus, Calcium, and Nitrogen Required by Crops, Compared with that Possible of Solution when Nitrite Bacteria Act upon Tricalcium Phosphate

(Expressed in Pounds)

Crop	Nitrogen Required	Phosphorus		Calcium	
		Required	Possible	Required	Possible
Corn:					
Grain, 100 bu.; Stover, 3 tons; cobs, ½ ton	150	23	166	22	321
Wheat:					
Grain, 50 bu.; straw, 2½ tons	96	16	107	11	206
Oats:					
Grain, 100 bu.; straw, 2½ tons	97	16	108	17	208
Timothy, 3 tons	76	9	84	20	163

An inspection of the figures shows that there is, by weight, approximately twice as much phosphorus and four times as much calcium made soluble as there is nitrogen oxidized by the bacteria. As an average of the results from thirteen flasks (Nos. 4 to 16), we find that from the oxidation of 56 pounds of nitrogen 115 pounds of phosphorus and 211 pounds of calcium are made soluble. (The results from Flasks 1, 2 and 3 are not included in the ratio calculated.) According to theory, when 56 pounds of nitrogen are changed from the ammonia form to the nitrite form, with both the nitrous acid (HNO_2) and the associated sulfuric acid (H_2SO_4) acting on the pure rock phosphate, 124 pounds of phosphorus and 240 pounds of calcium are made soluble.

Ten cubic centimeters of Flask 16 required 3.35 cc. of N/12.5 NaOH with phenolphthalein as the indicator for the second hydrogen atom. The normality of the solution was found to be N/37.2.

IMPORTANCE AND EXTENT OF THE ACTION OF NITRITE BACTERIA

It has already been shown that the nitrite bacteria make phosphorus and calcium soluble from pure rock phosphate and that the action conforms to a definite chemical ratio.[4]

[4] It was found that the action of the nitrite bacteria was the same on the natural raw rock

The nitrous acid produced may act upon compounds of iron, aluminum, potassium, sodium, or magnesium which occur in soils, or it may act upon tricalcium phosphate, calcium silicate, or calcium carbonate, if present. For this reason, it has been recommended that the ideal practise to obtain the greatest solubility of the raw rock phosphate is to turn it under in intimate contact with organic matter, and, if needed, to apply ground limestone after plowing or at some other point in the crop rotation.

In Table II. are presented the actual amounts of phosphorus, calcium and nitrogen required by standard crops, and the amounts of phosphorus and calcium which would be made soluble if all the nitrogen required for the crop should be oxidized to nitrate and should act upon pure rock phosphate.

TABLE II

Nitrogen Oxidized, and Phosphorus and Calcium Made Soluble by Nitrite Bacteria
(Expressed in Milligrams)

Flask	Duration in Days	Nitrogen Oxidized	Phosphorus Made Soluble	Calcium Made Soluble
1	28	2.54	4.08	3.87
2	41	4.81	5.08	5.60
3	41	....	5.99	8.40
4	48	5.52	9.56	14.80
5	48	4.88	10.20	18.40
6	55	6.40	12.85	22.00
7	55	6.40	10.24	23.52
8	62	6.88	16.00	31.04
9	48	3.61	7.52	13.60
10	62	3.87	8.76	16.48
11	62	5.84	9.82	16.00
12	62	5.68	11.28	20.80
13	69	6.03	11.14	22.40
14	48	5.76	13.04	24.80
15	69	4.60	11.60	19.20
16	139	18.84	41.56	75.26

The figures show that there is possible of solution from this biochemical process about 7 times as much phosphorus as corn, wheat or oats require, and 9 times as much as timothy requires. Greater differences occur in the calcium figures, there being possible of solution 14 times that required for corn, 18 times that required for wheat, 12 times that required for oats, and 8 times that required for timothy.

phosphate as on the pure rock phosphate, but more extensive experiments with the natural rocks will be reported later.

SUMMARY

1. Nitrite bacteria make phosphorus and calcium soluble from insoluble phosphates when they oxidize or convert ammonia into nitrite.

2. The actual ratio found shows that about one pound of phosphorus and about two pounds of calcium are made soluble for each pound of nitrogen oxidized, aside from the action of the acid radicles associated with the ammonia.

3. The ratio of solubility found on the basis of nitrogen to phosphorus and calcium conforms to the following reaction:

$$4HNO_2 + Ca_3(PO_4)_2 = CaH_4(PO_4)_2 + 2Ca(NO_2)_2.$$

According to this equation, 56 pounds of nitrogen liberate in soluble form 62 pounds of phosphorus and 120 pounds of calcium.

4. Neither ammonia-producing bacteria nor nitrate bacteria liberate appreciable amounts of soluble phosphorus from insoluble phosphates.

More complete details of these experiments will be published in Bulletin No. 190 of the University of Illinois Agricultural Experiment Station.

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THE AMERICAN CHEMICAL SOCIETY
II

The following papers were read and discussed.

The So-called Caseinates: W. D. Bancroft.

Action of Rennin on Caseine: W. D. Bancroft.

The Aeration Method for Total Nitrogen Determinations: R. S. Potter and R. S. Snyder.

Titrimetric Determination of Nitrite N: B. S. Davisson.

Determination of Ammonia by Aeration: B. S. Davisson.

A Study of Carbohydrates as Milk Modifiers: Ruth Wheeler.

The Relation of a Diet High in Calcium to the Calcium Content of Tissues: Amy L. Daniels.

Report of a Survey of the Food Conditions at Sing Sing Prison: EMILY B. SEAMAN.

The Relation of Biological Chemistry to Problems of the Community: EMILY B. SEAMAN.

Washing and Cleaning: W. D. BANCROFT.

Whipped Cream, Etc.: W. D. BANCROFT.

Mayonnaise: W. D. BANCROFT.

On Soap Jelly Formation: G. H. A. CLOWES.

NaCl or other Na salts added to slightly alkaline soap solutions cause jelly formation between .2*N* and .4*N*, and precipitate at higher concentrations.

Same salts added to neutral or slightly acid soap cause opalescence at .2*N*, gradually increasing until complete precipitation occurs above .4*N*.

Degree of dispersion of negative soap particles depends on adsorbed anions derived from added alkali. Subsequently adsorbed cations cause aggregation. Larger particles with smaller charge precipitate earlier, smaller particles with larger charge coalesce later forming jelly. If at critical cation concentration particles still exhibit active Brownian movement, jelly is subsequently formed enclosing water in interspaces, otherwise precipitation occurs.

On Filtration of Blood Plasma: G. H. A. CLOWES AND F. WEST.

In 1913, writers confirmed Cramer's observation that citrated plasmas may be obtained by filtration through Berkefield bougies which coagulate with thrombin but not with calcium alone. Bougie removes lipoids. Addition of sterilized brain lipoid one part in 50,000 causes coagulation with calcium. Added lipoid may be entirely removed by second filtration prior to addition of calcium. Resulting filtrate does not clot with calcium.

Cleaned and sterilized bougies often contain sufficient calcium to cause local coagulation of plasma with consequent production of thrombin which passes into the filtrate, complicating subsequent experiments. This may afford explanation of Goddard's results.

Mechanism of Blood Coagulation: G. H. A. CLOWES.

Dispersion of negatively charged fibrinogen and lipoid particles is normally maintained by adsorbed anions. Analogous, antagonistic, electrolyte effects in emulsions, jellies and blood coagulation suggest probability that Ca by adsorption first lowers charge and promotes deposition of lipoid film on fibrinogen particles, and subsequently Ca soaps, being freely dispersed in lipoids involved, cause surface tension changes and transposition of phase relations analogous to those observed in emulsions, the previously dispersed fibrinogen becoming the continuous fibrin clot in which water is more or less dispersed. Presumably thrombin, by local adsorption, promotes hydrolysis, liberates acid groups, lowers negative charge, raises surface tension, and so promotes aggregation.

Investigation of the Kjeldahl Method for Determining Nitrogen. A New Aeration Apparatus: I. K. PHELPS AND H. W. DAUDT.

Folin's method for determining ammonia is adapted to the Kjeldahl method. All of the operations, including the measurement and addition of the sodium hydroxide solution, the passing of air through the resulting alkaline solution and the absorption of the ammonia in standard acid are carried on by means of air pressure or suction. The advantages over the more commonly used distillation method are discussed.

Remarks on the Physical and Biological Chemistry of Fat: MARTIN H. FISCHER.

The general principles governing the production and the destruction of water-in-oil and oil-in-water emulsions and their general properties are discussed. Protoplasm represents ordinarily a fine oil-in-water emulsion. The characteristic feature of "fatty degeneration" is a coalescence of these fine droplets into coarser ones, the conditions producing such being identical with those producing the coarsening of an oil-in-water emulsion. Adipose tissue, butter formation and the formation of fatty secretions consists in the conversion of the oil-in-water type of emulsion into the water-in-oil type. The experimental facts underlying these conclusions are illustrated.

Studies Upon the Effects of Acids: ARTHUR D. HIRSCHFELDER.

Repetition of the experiments of Hofmeister and Martin Fischer on the swelling of fibrin in mixtures of acids and neutral salts, show that the solutions in which swelling seems to be inhibited (except the sulphates) are much poorer in hydrogen ions than the corresponding ones in which this is only slightly the case; and that when these are all brought to the same hydrogen ion concentration the amount of swelling is the same in all the solutions except those containing sulphates which markedly inhibit. Varying either the chlorine ions or the other ions to bring about the acidification gives the same results. Adding a little dilute H_2SO_4 or Na_2SO_4 to mixtures already swollen under the influence of other acids causes marked shrinking.

However, injection of phenolsulphonphthalein,

phenolphthalein, rosolic acid and para nitrophenol into conjunctivæ of rabbits rendered markedly edematous with mustard oil, shows the reaction of the edematous tissue to be slightly on the alkaline side of neutral, very close to the reaction of the animal's blood. Excised bits of lid and conjunctivæ give no such edema in Ringer's solution acidified to various degrees.

These facts are not in harmony with the acid theory of edema.

Brain Lipoid as a Hemostatic: ARTHUR D. HIRSCHFELDER.

Kephalin has been shown to be identical with thromboplastin. An active preparation can be made from an ether extract of ox brain. The residue of such an extract or a weak emulsion of it in salt solution, when placed on an oozing surface of tissue stops bleeding very quickly and gives a very clean field for operation.

Hemorrhage from bone, kidney, muscle and connective tissue, prostate and other glands, are easily controlled by this means. Hemorrhage from cut artery can not be controlled instantly because the force of the blood pressure pushes away the clot as fast as it can be formed. In a pitted wound, however, such as occurs in warfare or when the femoral artery is cut through in Scarpa's triangle, and the pitted wound fills with blood, application of the lipoid causes it to stop spontaneously because a thick enough layer of fibrin can be formed.

The solution of lipoid residue keeps several months. It is rendered sterile by its preparation, and is very useful for practical surgery as well as for laboratory operations.

The Rôle of Cystine in the Maintenance of Nitrogenous Equilibrium in Dogs on a Low Protein Diet: HOWARD B. LEWIS.

The Excretion of Uric Acid After Ingestion of Sodium Benzoate in Man: HOWARD B. LEWIS AND WALTER G. KARR.

During the first four hours following ingestion of large doses (7–8 gm.) of sodium benzoate by healthy men, the periods during which maximal elimination of hippuric acid was taking place, the uric acid elimination was decreased from 50 to 70 per cent. as compared with the elimination in corresponding periods of control days. No compensatory increase in uric acid excretion occurred in later periods. Creatinine elimination was not affected. The ingestion of amounts of sodium hippurate equivalent to the benzoate fed in the previous experiments had no influence on uric acid excretion.

A Comparative Study of the Urea Content of the Blood and Tissues of Some Vertebrates: WALTER G. KARR AND HOWARD B. LEWIS.

The urea concentration of the tissues of normal guinea-pigs is the same as that of the blood (20–30 mg. per 100 c.c.) with the exception of the kidneys, in which the presence of urine results in high figures. The urea content of the blood of fasting guinea-pigs or of pigs on an insufficient diet may rise to 6–7 times the normal figure with a less marked rise in the concentration of urea of the tissues in most cases. The urea concentration of the blood and tissues of hens is low (5–10 mg. per 100 c.c.), the kidneys having no higher concentration of urea than any other tissue. Injection of alanine into hens causes no rise in the urea content of blood or tissues.

On the Esterification of Amino Acids: H. A. SHONLE AND H. H. MITCHELL.

The following method of determining the rate and extent of esterification of the amino acids of proteins is reported. The protein is hydrolyzed and the hydrolysate prepared for esterification (Phelps-Tillotson) as usual, except that decolorization is effected by making alkaline with $Ba(OH)_2$ before removal of the water, filtration, and subsequent removal of the barium. During the esterification small samples are removed and diluted with 95 per cent. alcohol to a definite volume. In one aliquot the total acidity is determined by a Sörensen formol titration; in another, the mineral acidity by a Cl determination (Volhard). The remainder is completely saponified by boiling with HCl, made up to volume, and the above determinations repeated. From these data the per cent. of unesterified amino acidity may be calculated.

The Preparation of a Synthetic Milk for Use in Studying Infant Metabolism: A. W. BOSWORTH.

The method in brief consists of four steps as follows:

1. The preparation of isolated food materials for use in making the synthetic milk.
2. The recombining of these materials to give a mixture of the desired percentage composition.
3. The emulsification or homogenization of the fat and any of the solid or insoluble constituents entering into the composition of the food.
4. The pasteurization or sterilization of the food after it has been made.

Concerning the Utilization of Inosite in the Animal Organism. The Effect of Inosite upon the Metabolism of Man: R. J. ANDERSON AND A. W. BOSWORTH.

A study of the channels of elimination and the influence of inosite upon the metabolism of man. It is shown that in man inosite is eliminated only through the kidneys. About 91 per cent. of the ingested inosite disappears and only some 9 per cent. is excreted in the urine. When inosite is given at the rate of 0.5 grams per kilo of body weight it causes some diarrhea, but aside from this no other disturbance was observed; and with the exception of an increased excretion of creatinine it had no marked influence upon the metabolism of man.

Concerning the Utilization of Inosite in the Animal Organism in the Dog: R. J. Anderson.

These experiments were made with the object in view of throwing some light upon the fate of inosite in the animal organism and to determine whether inosite is utilized in such a way as to cause a rise in the respiratory quotient of a fasting dog.

The results show, first, that there was no rise in the respiratory quotient; second, that as much as 77 per cent. of the ingested inosite was recovered in the excreta, and third, that inosite is absorbed very slowly from the intestine of a dog and hence the greater portion is eliminated with the feces.

Studies on the Distribution of Nitrogen in Egg Lecithin: Mary Louise Foster.

The fact that the Herzig and Meyer method for determination of methyl groups gave inconclusive evidence of the pressure of choline in lecithin has led the author to study the distribution of the nitrogen in lecithin. Merck's preparation of egg lecithin was purified and used for analysis. The methods employed were Kjeldahl with Arnold-Gunning modification for *total nitrogen*. Hausmann's method as modified by Osborne for the *anrich*, and *diamino nitrogen* and the Styli's method for *total amino nitrogen*. The results seem to indicate that the amide nitrogen represents less than 2 per cent. of the total, monoamino nitrogen about 40 per cent. and the diamino nitrogen about 50 per cent.

Further work is in progress.

Presence of Creatinine in Urine of Children: Louise Stanley and Emma B. Wagner.

We have planned a series of observations on the urine of children of various ages. In each case we obtained at least three samples for determination of creatine and creatinine in 100 c.c. of urine. We have tried in each to check this up by a twenty-four hour sample. The diets we were not able to control in all cases. We were, however, able to get very accurate information in regard to them. We find that there is a very great irregularity of the proportion of creatine to creatinine. This variation is less in the case of babies on regular diet. It is quite as irregular on a creatine-free as on a creatine diet. In boys, it was present in the urine of a boy at ten while absent in his brother, aged twelve. Both were normal and active and on an ordinary mixed diet. In girls, it seems it may continue to puberty, where it appears intermittently in connection with the menstrual cycle. In some girls it disappears entirely before puberty. This phase we are at present investigating further. We hope to continue the investigation for several years and check further by determining the age at which it disappears from the urine of some of the children under observation. Our figures show that the diet plays an important function in the amount of creatine in the urine. It has been shown by other investigators that in starvation the feeding of carbohydrate decreases the amount of creatine in the urine. McCrudden has shown that increasing the carbohydrate in the diets of children causes not a decrease but if any change an increase in the creatine of urine. We have some evidence which tends to support this observation. This seems to us, however, to support the idea of a relationship between carbohydrates and creatine metabolism rather than the opposite which McCrudden is trying to prove. It seems quite possible that if the excretion of creatine is connected, as Rose suggests, with carbohydrate metabolism, you would expect a decrease on feeding carbohydrate in starvation. On the other hand, where there is a metabolic condition which results in a creatine excretion on a regular diet, this condition, if caused by carbohydrates, would be aggravated by the addition of more carbohydrate.

We have results which tend to support this theory and this will be the hypothesis upon which our future experiments will be planned.

A Bacteriological Study of Hamburger Steak: Edwin LeFevre.

In a study of hamburger steak, as sold in the public markets, the author, following the suggestions of Weingirl and Newton, worked out a technique which seems to afford the most satisfactory method for the bacteriological examination of chopped meat. The essential feature of the method is the careful selection of ten grams of lean meat from a pound of the product, this being ground up in a mortar with the aid of white sand and a 0.5 per cent. solution being added with continued grinding to secure the proper dilution for

plating. Beef infusion agar at + 1.5 to be used in making counts.

Two series of samples from ten dealers were examined. In the first series collected in mild weather, *six* samples gave total counts of over ten million per gram. In the second series collected during colder weather *five* samples gave counts of over ten million. Meat from three dealers showed exceedingly high counts in both series, indicating that bad methods were followed.

The chief cause for high counts is to be found in the practise of utilizing scrap meat or meat of inferior quality which is often collected and held for some time before being ground up for sale.

Attention is called to the value of bacteriological analyses as a means of determining the methods used by dealers and to the importance of this test being more generally resorted to in connection with chopped meats for the purpose of establishing proper standards and securing an efficient sanitary control.

Cleaning Silver by Contact with Aluminium in Alkaline Solution: H. L. LANG AND C. F. WALTON, JR.

This paper is a preliminary report of results obtained in cleaning silver under household conditions by the electrolytic method. Sodium carbonate was found to be slightly more efficient than the bicarbonate as the electrolyte of the method, one teaspoonful of each washing soda and table salt to the quart of water proving the most economical concentration. The best results were obtained when the cleaning solution was kept at the boiling temperature during the cleaning, and aluminium proved more efficient than zinc as the active metal in contact with the silver.

The principal advantage of the electrolytic method, as compared with cleaning by an abrasive polish, is that it saves labor. In addition it is convenient and clean, and removes the tarnish from both sterling and plated silverware without appreciable loss of the metal.

Iron Rust Stains and Their Removal: New Methods: HAROLD L. LANG AND ANNA H. WHITTELSEY.

In an experimental study of the removal of stains from textiles several new or little-known reagents were found successful for the treatment of iron rust spots. A 15 per cent. solution of titanium trichloride, $TiCl_3$, applied cold to the stain was found to be very efficient, although an expensive reagent. Iron rust stains could also be removed by boiling for several minutes in solutions of potassium acid tartrate (cream of tartar), tartaric acid or citric acid, or in an infusion of the stalks, leaves or fruit of certain plants which contain oxalic or other acids. Among these plants are rhubarb, the begonia (a rather common house plant), the pineapple, and the grapefruit. These reagents have the advantage that they may be readily obtained and are less liable to injure the fabric or its color than are hydrochloric and oxalic acids, whose efficiency are well known.

Solutions of Lead and Antimony from Enameled Cooking Utensils: ELIZABETH W. MILLER.

Fifteen different makes of enameled dishes were boiled with 4 per cent. acetic acid and the solution tested for lead and antimony. Slightly less than 2 mg. of lead per liter were dissolved from the saucepan of standard make. Three others of the same kind gave mere traces.

Antimony was extracted by acetic acid in considerable amount from one cheap gray dish. Grape juice, cider and cranberry pulp, milk and spinach were cooked in dishes of this same make. All these foods contained antimony in amounts ranging from 2.3 mg. in 200 c.c. of milk to 14 mg. in 200 c.c. of cranberry pulp.

History and Present Methods of Fluorspar Production in Illinois: CARL C. LUEDEKING.

The author after giving a short history of the mining and milling methods of fluorspar in Pope and Hardin counties, Illinois, enters into the details of present-day status in this industry. It appears that four fifths of the fluorspar of the United States comes from the Fairview and Rosi Clare mines of Hardin County, Illinois. In 1914 these mines have produced 70,000 of the 78,000 tons of fluorspar used in this country. In 1915 the production increased to 115,000 tons. The fluorspar is used chiefly in the basic open hearth steel furnaces and for enameling.

The Chemistry and Technology of Glass: ALEXANDER SILVERMAN.

After a brief introduction on the history of glass making, followed by a statement concerning raw materials, their functions and uses, the technology of glass making was illustrated by about sixty lantern slides. A discussion of coloring and decolorizing agents followed and parallels were shown between aqueous and vitreous solutions of gold, compounds of uranium, copper, cobalt, aluminium, chromium, etc. Specimens of glass and related aqueous solutions were exhibited to illustrate the points discussed. Data on the treatment of glass included recent developments in etching, polishing and silvering processes. The importance of careful and comprehensive research in this

branch of industrial chemistry, and the necessity for endowment of such research, were emphasized.

New Volumetric Determination of Nickel and Cobalt: W. D. ENGLE AND R. G. GUSTAVSON.

Preliminary Report—Deposition of Copper in Electrotyping Baths: W. BLUM, H. D. HOLLER, H. RAWDON AND E. L. LASIER.

From a study of the microstructure and physical properties of copper, deposited upon graphited wax molds in the copper sulphate-sulphuric acid bath, the effects of the composition and temperature of the electrolyte and of the current density, upon the character of the deposits, have been determined. The conditions for the production of satisfactory electrotype shells have been defined. The relations between microstructure and physical properties, and the effect of annealing, are being investigated.

Let's Abolish Our Unnecessary Waste of Potassium Compounds: JAMES K. WITHROW.

Attention is called to the fact that in case of sudden cessation of imports great hardship is done not only to chemical users of potassium compounds but many manufacturers of miscellaneous materials who are not in the category of chemical manufacturing and who do not have chemical advice to assist them in meeting the emergency on which they are thrown. A strong appeal is made for publicity in eliminating all unnecessary use of potash so that hardship will be avoided in such cases, and to give manufacturers of sodium compounds ample opportunity to build up their supply under non-emergency conditions. All of this, so that in case of great national emergency, we may direct our attention as much as possible to other situations which can not be avoided by any previous arrangement. Attention is called to the fact that in our schools and colleges our chemical texts persistently require the use of potassium compounds where experience has shown that sodium compounds would do just as well. If we can eliminate this and similar unnecessary waste the percentage saving may not be so great but the educational value can not be estimated for it is quite common for enormous amounts of potash to be wasted in ordinary manufacturing and everyday life as well as in chemical operations.

Experiments on the Corrosion of Iron and Steel: W. D. RICHARDSON.

Ethyl Alcohol from Wood Waste. IV. Yields from Various Species of Wood: F. K. KRESSMANN.

A Note on "Tars" from Some Mid-western Cannel Coals: JOHN C. INGRAM.

Cannel coals from Missouri and Illinois were distilled at 800° C. in iron retorts and the "oil" or "tar" collected. Yields of water-free tar varied from 30 to 50 gallons per ton. A typical sample (gravity 0.906) gave on distillation the following fractions:

To 150° C.	......12 per cent.....	Gravity 0.752
150°–200°	.... 6 per cent......	" 0.788
200°–240°	.... 9 per cent......	" 0.820
240°–270°	.... 8 per cent......	" 0.880
270°–300°	.........16 per cent......	" 0.912
300° to coke	........35 per cent......	" 0.945

The tars are largely made up of paraffin hydrocarbons, but seem to contain about 7 to 8 per cent. of tar acids. On standing these tars separate into two layers, the lower layer is semi-solid and shows a partial segregation of heavy paraffines. On centrifuging, four distinct products are obtained.

		Gravity
(1) In bottom	..tar (mainly aromatics)	1.02–1.06
(2) 1st liquid	....................water	
(3) 2d liquid	.....heavy, viscous liquid	.96– .98
(4) 3d liquid	................light oil	.79– .85

Comments on the Krebitz Process of Soapmaking and Glycerol Recovery: G. A. WRISLEY.

After double decomposition of the lime soap with soda ash, the soap is salted out and the lime $CaCO_3$ allowed to settle. It was impossible to prevent occlusion of 10 to 20 per cent. of soap. Attempts to wash out the soap by a series of washings and filtration were unsuccessful, because of slow filtering and loss of 5 to 10 per cent. of soap in the lime cake. It was found that on adding water to this mixture with thorough agitation a point was reached where the lime sludge settled out occluding only 3 to 5 per cent. of soap. This mixture was filtered easily and less than 1 per cent. of soap was lost in the lime cake.

An Unusual Explosion in Connection with Potassium Chlorate: F. E. ROWLAND.

Laboratory Control in the Manufacture of Corn Syrup: A. P. BRYANT.

Effect of Aging upon the Constants of Chinese Wood Oil: D. F. MCFARLAND AND H. R. LEE.

Effect of Fillers in Synthetic Molding Compounds: L. V. REDMAN, A. J. WEITH AND F. P. BROCK.

Printing Plates from Phenol Resins: L. V. REDMAN, A. J. WEITH AND F. P. BROCK.

The Effects of Moisture Introduced into the Digester in the Cooking of Soda Pulp: SIDNEY D. WELLS.

(*To be continued*)

CHARLES L. PARSONS
Secretary

SCIENCE

FRIDAY, AUGUST 25, 1916

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MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

ADDRESS AT THE DEDICATION OF THE MITCHELL MEMORIAL BUILDING OF THE PHILADELPHIA ORTHOPÆDIC HOSPITAL AND INFIRMARY FOR NERVOUS DISEASES[1]

OBSERVE the title of the building we are assembled to dedicate—the Mitchell Memorial Building of the Philadelphia Orthopædic Hospital and Infirmary for Nervous Diseases. It is not the *S. Weir* Mitchell or the *Weir* Mitchell Memorial, but simply the "*Mitchell* Memorial" Building.[2] As there are many Franklins but only one Franklin, so there are many Mitchells but only one Mitchell.

I first saw Weir Mitchell on the third of September, 1860, just as I was beginning the arduous study which has filled a long life time. The last time I saw him was at Christmas time in 1913, just before the shadow of death fell upon him. The interval covered fifty-three years and four months—a long time for an intimate friendship which never knew a cloud even as big as a man's hand.

He was my senior by only eight years, but, having graduated ten years before I began even to study medicine and having already an established reputation, I always looked up to him as my father in the profession rather than as an elder brother.

I first aided him in his experiments on the poison of snakes—a study which for almost half a century fascinated him and to which he, first alone, and later with

[1] By Dr. W. W. Keen, consulting surgeon to the hospital.

[2] This was the name then on the new building. Later it was replaced by the "Silas Weir Mitchell Memorial."

Reichert and Noguchi, made most valuable contributions.

During these experiments one incident was an excellent illustration of the mental alertness which was so striking an element in Mitchell's character. One hot July just after we had collected one or perhaps two teaspoonfuls of the liquid snake-poison in a small cup Mitchell was called out of town for three or four days. Usually we immediately spread out this liquid in a thin layer so that it would dry quickly before decomposition set in, but by an oversight on this occasion it was left in the cup in bulk and naturally in such weather underwent quick decomposition. On his return we went to the laboratory and on opening the door were almost knocked down by the horrible stench. Who of us here would not have sought the source of the smell and in all haste have thrown it away. Not so Mitchell. Instantly he turned to me and said, "I wonder if decomposition has destroyed its poisonous character. Let's try it." That was always his desire—to put everything to the test of experiment. A single experiment showed that for a pigeon it was as virulent as ever. How subtle and potent was the poison that even decomposition left intact! But not to every form of life was it even then a poison, for disporting themselves in the cup were a host of nimble little animalculæ having apparently the time of their lives.

Within a half year of our first meeting came on the sterner studies of the Civil War—studies which he again illuminated by his brilliant investigations and in which I again had the great good fortune to be his assistant, especially in the Turner's Lane Army Hospital for Diseases and Injuries of the Nervous System in this city. This was only one of several special army hospitals for which science and the American soldiers were indebted to Mitchell, for it was he who suggested the idea to Surgeon-General Hammond.

In fact I have always felt that my intimate acquaintance with Weir Mitchell was the first of three epochal events in my life. The stimulus and direction of my professional life began in those days with him as the dominant factor. I have always gladly acknowledged this great debt. I have met and known many of the best in medicine and surgery in America and in Europe and I say unhesitatingly that Weir Mitchell was the most original, fertile, stimulating medical man I have ever met either here or abroad.

Early in his professional life a vacancy occurred in the chair of physiology at his alma mater, the Jefferson Medical College, a position for which his studies in anatomy, physiology and toxicology had preeminently fitted him. But the trustees had not the vision, the imagination to discern the genius they might have obtained. A very few years later the University of Pennsylvania trustees also were equally blind and so he never became a "professor."

But years afterward he had the privilege as a trustee of the University of Pennsylvania to elect professors. The fight over his election to the board was one between the conservatives and the progressives and under the leadership of William Pepper, H. C. Wood, Tyson, Harrison Allen, and their valiant friends, Mitchell was elected, and a new University of Pennsylvania Medical School arose.

Calling on him after the election, Allen, by a happy quotation, well described Mitchell's status

Thou shall not be King but thou shalt beget Kings.

What discoveries he would have made, what a school of young experimental physiologists he would have created, had either of those two great schools but appreciated the genius they might have had we can only guess.

But these two, for him, fortunate defeats, and his experiences in the Civil War

decided his career. Thenceforward all his powers, all his energies, were devoted to neurology—then almost a new department of medicine with which we are now so familiar.

His very touch was vibrant with the restless mental forces within him. Every institution with which he was connected, every committee he was on, took on a new and vigorous life. The University of Pennsylvania, the College of Physicians, the Directory for Nurses, the Philadelphia Library, and in later life the Carnegie Institution and this hospital, all felt the throb of his genius.

Another evidence of Dr. Mitchell's wide influence and at the same time a beautiful tribute to his memory, so modestly done that I have only just heard of it, is the fully equipped Convalescent Home for Children established by Miss Anne Thomson near Devon. While other hospitals share in this bounty, Miss Thomson's first thought was for this hospital so dear to Dr. Mitchell's heart and therefore to her own. The same potent influence won for you the services of your invaluable president.

In 1871 his connection with the Orthopædic Hospital began. He had thirsted for several years for the wider circle of clinical opportunities which a hospital would give for the observation of neurological diseases. There was no hospital in Philadelphia which had even so much as a ward for these sorely suffering patients, often indeed derelicts on the sea of humanity. Indeed, there were then but six such hospitals in all Europe and only two others in the United States. Mitchell, with quick vision, recognized his opportunity. Many of the results of nervous diseases, especially of their palsies, resulted in deformities and disabilities which could only be remedied or alleviated by orthopædic surgery.

In 1867 on Ninth Street, between Market and Chestnut Streets, Thomas G. Morton, H. Earnest Goodman, Agnew and the two Grosses had founded a small "Orthopædic Hospital." Mitchell joined forces with them and from this little mustard seed has grown this great tree, whose branches have indeed been for the healing of the nations, for its patients drawn especially by Mitchell's great reputation came not only from all over the United States, but from foreign countries as well.

The name was lengthened in 1893 to "The Orthopædic Hospital and Infirmary for Nervous Diseases." If I may be allowed a linguistic license the tail began by being longer than the dog and it ended by its wagging the dog. As I was formerly on the active and am now on the consulting surgical staff this homely simile is perhaps permissible.

By 1873 their narrow quarters became too strait for the rapidly growing hospital and they removed to Seventeenth and Summer Streets, where an old residence was fitted up. Then the community recognized it. Funds began to be given and bequeathed and patients multiplied. A few years later (1887) a new hospital building on the site of the old residence was opened, Mr. Kuhn being the chairman of the building committee. This in turn was outgrown and successively adjoining lots were purchased until now the hospital owns seven lots with a front of 224 feet on Summer Street and 116 feet on Seventeenth Street, though the last lot (no. 1713), presented to the hospital as a memorial to his father by the liberal and energetic president, C. Hartman Kuhn, Esq., is as yet not physically incorporated into the hospital.

A live growing hospital, like a live growing baby, is always greedy for nourishment, but unlike the baby never suffers from indigestion. There is a hospital physiology which differs from that of animals and humans. Even a gorging Thanksgiving dinner followed by a dessert

up to the bursting point—in the case of the hospital a dessert of thousand-dollar checks—never "upsets" but actually "sets up" both its appetite and its digestion.

The above I give you notice is the most important paragraph in my whole address.

For eight years, from 1890 to 1898 I was so fortunate as to be Mitchell's colleague as one of the three orthopædic surgeons and I can testify, therefore, from my experience, both in the Civil War and in this hospital, to the wonderful stimulating influence which Dr. Mitchell exerted. This was manifested not only in the conduct of the hospital, but in his influence on the medical and surgical staff and especially on his own assistants, on the resident physicians, and on the many doctors who flocked to his weekly clinics and bore away with them an inspiration for good work all over the land.

These bright men of mature years sat at the feet of the master to be taught much that the best of them did not know, to catch glimpses of the guesses of genius which later grew into the certainties of science, to hear and repeat his many picturesque and impressive descriptions or happy or pungent phrases, struck like sparks off the anvil.

But while visiting strangers were welcomed and departed with many a sheaf, it was his regular assistants and the residents in the hospital who were indeed twice blessed. To begin with a new patient; to observe Mitchell's careful cross examination as to the earliest symptoms; his minute following up of even a stray hint which to an ordinary man would have meant little or nothing, but which to Mitchell was a veritable guide post to the right road; to hear him compare or contrast this case with other similar or opposite cases garnered by an accurate memory from the myriad cases seen one year, five years, ten or even twenty years before; to see how he inevitably put his finger on the exact central fundamental lesion which to others was obscured by the many surrounding minor symptoms; a diagnosis made often seemingly by intuition; to follow his treatment until betterment or cure or in rare cases death closed the scene; this was a liberal education in itself.

At my request a list of the men who have been his colleagues or assistants has been furnished to me. I find that they were nearly 160 in number. To call this notable roll in your hearing is of course impossible. But I can not refrain from mentioning a few of the more conspicuous—names known to most of you as leaders not only in this community but throughout this country and not a few of world-wide fame: Wharton Sinkler, Morris J. Lewis, William J. Taylor, J. Madison Taylor, John K. Mitchell, Charles W. Burr, G. G. Davis, F. X. Dercum, George E. deSchweinitz, Charles K. Mills, Barton C. Hirst, John H. W. Rhein, A. P. C. Ashhurst, D. J. McCarthy, Guy Hinsdale, of Hot Springs, Va., Edward B. Angell, of Rochester, N. Y.

I have only named one tenth of this ever-faithful cohort. We, the other 90 per cent., may well rest content, however, in the consciousness of daily duty well done. In the forum of one's own mind and conscience the ultimate and most cherished judgment seat is established.

One noteworthy fact demonstrates how stimulating was his influence. Twenty-five of the men who served this hospital in the eighteen years from 1889 to 1907 contributed 522 papers to medical and surgical literature. Not all, not even a majority of these were papers on neurology or orthopædics, but the incentive, the stimulus to writing, was largely the result of Mitchell's precept and example.

While I was on the active staff the daily out-patient service was constantly growing larger and larger. The noise and confu-

sion, the dirt, especially on rainy and muddy days, were increasing and the desire for separate quarters for this daily throng was constantly growing more insistent.

Up to the end of 1908 while the house patients totaled 10,936 there had been 180,555 patients cared for in the out-patient clinics. This is a large number, but it covers many years. For the last year, 1915, the number cared for in this clinic was only 150 less than 26,000, largely over 2,000 patients every month! For the seven years from 1909 to 1915 the total number was 156,385. This year, 1916, will bring up the number for the past eight years to more than had been treated in the 42 years after the little hospital was started on Ninth Street in 1867.

When Dr. Mitchell passed away early in 1914 the opportunity came for relieving the hospital itself from this burden and at the same time for founding a worthy and spontaneous memorial in the hospital to which he had given of his best for so many years of his busy life. A large committee, numbering fifty to sixty, consisting of the members of the board, the members of the medical and surgical staff and assistants and many women was formed with Dr. Charles W. Burr as chairman, Mr. Charles Sinkler as secretary, and Mr. John W. Brock as treasurer. Through their abounding efforts even in the depressing financial conditions preceding the Great War the money to erect the memorial was obtained.

Right opposite to the hospital, across Seventeenth Street, stood the parish house of the chapel of the Epiphany Episcopal Church, unused and for sale. The lot measures 80 feet, 9 inches on Seventeenth Street and is 107 feet deep. It was purchased for $40,000. The alterations, furnishings and equipment have cost about $20,000 additional, a total, therefore, of $60,000. It is away from and not physically a part of the hospital, yet is within a few steps; convenient of access yet keeping all noise, dirt and possibility of contagion away from the house patients, whose quiet comfort and speedy recovery are thereby greatly promoted.

Had Dr. Mitchell himself been consulted, no memorial more pleasing to him could have been devised. No stately mausoleum, useless alike to the living and the dead, would have appealed to him. A busy clinic where thousands upon thousands will be helped back to joyous life because it is a useful life—this I am sure he would have thought the most grateful homage from his many friends.

W. W. KEEN

A NOTE ON THE SERUM TREATMENT OF POLIOMYELITIS (INFANTILE PARALYSIS)[1]

THE epidemic of poliomyelitis that is prevailing at the present time so extensively in New York and in some degree widely throughout the United States has led to many inquiries being made regarding the serum treatment of the disease, and particularly of the stage to which the treatment has advanced. This brief paper is intended not only to answer such inquiries, but also to provide a basis for the wider employment of the treatment where the difficult conditions surrounding the obtaining of the immune human serum can be surmounted.

It was demonstrated by Flexner and Lewis,[2] and afterwards confirmed by several investigators, that monkeys which had recovered from an attack of poliomyelitis induced experimentally were not subject to successful reinoculation with the virus of the disease. This was followed by the detection by Römer and Joseph[3] and later by others in the blood of

[1] From The Rockefeller Institute for Medical Research, New York.

[2] Flexner, S., and Lewis, P. A., "Epidemic Poliomyelitis in Monkeys," fourth note, *J. A. M. A.*, 1910, LIV., 45.

[3] Römer, P. H., and Joseph, K., *Münch. med. Woch.*, 1910, LVII., 568. Levaditi and Landsteiner, *Comp. rend. Soc. de biol.*, 1910, LXVIII., 311. Flexner, S., and Lewis, P. A., "Experimental

such resistant or protected monkeys, and then by Levaditi and Netter,[4] and by Flexner and Lewis in the blood of human beings who had recovered from acute poliomyelitis, of immunity substances which possessed the power of neutralizing the virus of poliomyelitis when the serum and the virus were brought together in the test tube. Flexner and Lewis ascertained, also, that the serum of monkeys actively immunized[5] with the virus under conditions in which all symptoms of the disease were avoided, contained similar immunity bodies.

EXPERIMENTAL SERUM THERAPY

The next step taken was the determination by Flexner and Lewis that both the immune monkey[6] and the immune human serum[7] which exhibited the neutralizing power for the virus possessed also therapeutic properties for monkeys inoculated with the potent virus of poliomyelitis in contradistinction to the normal serum from the same animal sources which was devoid of those properties.

The experimental demonstration of the therapeutic activity of the immune sera was made in the following manner. Rhesus monkeys were inoculated (*a*) intracerebrally and (*b*) intranasally with a virus which had become adapted to the monkey and was highly potent. The effective intracerebral dose of a Berkefeld filtrate of a 5 per cent. emulsion of the spinal cord of an infected monkey was less than 0.01 c.c. Hence the quantity of the filtrate injected into the brain of the etherized monkeys varied from 0.01 to 0.1 c.c. The inoculations were made in the afternoon and the therapeutic treatment was begun the next day, or from eighteen to twenty-four hours later. When the virus was introduced by the nasal route the filtrate was not employed, but an emulsion of the spinal cord was rubbed upon the upper nasal mucosa.

The immune sera were applied by intraspinal or subdural injection. The usual method was to inject from 2 c.c. to 3 c.c. of the immune sera through the lumbar puncture needle daily for several days or daily for three injections followed by an interval of three days when the three injections were repeated. The conclusions reached from these experiments were in substance that if the quantity of virus is not in excess of a given dose, the infection can be either wholly prevented or the onset of the paralysis much delayed. In other words when dealing with the virus adapted to the monkey which induces poliomyelitis almost without exception and in which the symptoms are far more severe and the mortality far greater than occur in the disease in human beings, the immune monkey and human sera are capable of preventing in all but a few instances the development of the virus even when inoculated intracerebrally, and in the exceptional instances in which the development is not wholly prevented, the onset of the disease is much delayed. The power, therefore, to neutralize the virus possessed by the immune sera is exercised *in vivo* under severe experimental conditions almost as constantly as *in vitro* under relatively favorable ones.

In order that maximal effect of the immune sera may be secured it is necessary that the injections be made into the subdural space which can be readily and safely accomplished by means of lumbar puncture. The reason for this mode of application of the serum depends upon the facts that it is the most direct route to the central nervous tissues and, however the virus is introduced into the body, it establishes itself in the cerebrospinal meninges.[8]

Poliomyelitis in Monkeys,'' seventh note, *J. A. M. A.*, 1910, LIV., 1780.

[4] Levaditi and Netter, A., *Presse med.*, 1910, XVIII., 268. Flexner, S., and Lewis, P. A., seventh note, *loc. cit.*

[5] Flexner, S., and Lewis, P. A., ''Experimental Poliomyelitis in Monkeys,'' eighth note, *J. A. M. A.*, 1910, LV., 662.

[6] Flexner, S., and Lewis, P. A., seventh note, *loc. cit.*

[7] Flexner, S., and Lewis, P. A., eighth note, *loc. cit.*

[8] Flexner, S., and Lewis, P. A., seventh note, *loc. cit.* Flexner, S., ''The Contribution of Experimental to Human Poliomyelitis,'' *J. A. M. A.*, 1910, LV., 1105. Flexner, S., and Amos, H. L., ''Penetration of the Virus of Poliomyelitis from the Blood into the Cerebrospinal Fluid,'' *Jour. Exper. Med.*, 1914, XIX., 411.

It is logical, therefore, to endeavor to bring the immune serum in as high a concentration as possible into immediate relation with the seat of disease.

The power of the immune serum, when injected subdurally, to prevent the development of experimentally induced poliomyelitis in the monkey, is further indicated by experiments[9] in which, on the one hand, the virus has been injected into the blood under conditions insuring its escape into the meninges and, on the other, when an emulsion of the virus has been introduced directly into the meninges and followed later by the serum injection.

SERUM THERAPY IN MAN

This aspect of the subject has been imperfectly developed up to the present time. Netter[10] was the first to apply the data obtained by experiments on monkeys to the treatment of cases of epidemic poliomyelitis in man. He has published the results obtained in a series of thirty-five cases which he regarded as highly favorable to the method. He employed the serum from cases of poliomyelitis in which complete recovery from the acute condition has taken place some time and even as long as thirty years previously. The serum injections were given subdurally as early after the appearance and recognition of the symptoms of poliomyelitis as possible. The dose of the serum, which must, of course, be sterile but need not be inactivated, should be determined by the age of the patient and will, in part, be determined by the quantity of serum available. Probably doses ranging from five to twenty cubic centimeters will be found suitable, the injection to be repeated once or more times at twenty-four hour intervals according to clinical conditions and indications. The effects of the immune serum should be sought in the checking of the progress of the disease, namely the prevention or minimization of the paralysis when employed in the preparalytic stages, and the arrest of its extension when used in progressing paralytic conditions. Since the immunity substances have been determined by neutralization tests to persist in the blood for many years, it is probable as Netter has indicated that persons who have passed through an attack of poliomyelitis several years earlier may be utilized as sources of the serum; while reasoning from analogy it would probably be advantageous to prefer persons whose attack was less remote so as to insure as high concentration of the immunity bodies as possible. The conditions surrounding the injection of the serum are identical with those observed in the analogous case of epidemic meningitis. Before each dose of serum is injected a suitable quantity of cerebro-spinal fluid is to be withdrawn, and the injection should be made slowly. In choosing the person who is to serve as the source of the blood from which the immune serum is to be derived precaution should of course be taken to secure a healthy donor; it would be advisable to fortify the usual clinical examination by a Wassermann test.

SIMON FLEXNER

[9] Flexner, S., and Amos, H. L., "Localization of the Virus and Pathogenesis of Epidemic Poliomyelitis," *Jour. Exper. Med.*, 1914, XX., 249.

[10] Netter, A., "Serotherapie de la poliomyelite nos resultants chez trentedeux malades," Indications technique—incidents possibles, *Bull. de l'Acad. de Med.*, Oct. 12, 1915. Netter, A., and Salanier, M., "Deux nouveaux cas de poliomyelite a debut meninge gueris par les injections intrarachidiennes de serum d' anciens malades," *Bull. Mem. Soc. Med. des Hop. de Paris*, Mar. 10, 1916.

THE CULTURE VALUE OF SCIENCE[1]

WISHING not to squander any of the few minutes allowed me in this program, I have written down what I have to say, and hope you will pardon me if by reading I seem unduly formal for the occasion.

The Scripps Institution for Biological Research believes it has a mission over and above what is indicated by its name. As "nominated in the bond," its function is to produce new knowledge in the realms of nature with

[1] Remarks to the teachers of science in the secondary schools of southern California on the occasion of their visit to La Jolla and the Scripps Institution for Biological Research of the University of California during the teachers' institute week in November, 1915.

which it is occupied. But it would do something also toward the humanization of science. Its work is not only to *make* science, but to make science *human*. Concerning its science-producing function you will learn something to-day from the other members of the staff. So the time at my disposal may be devoted to saying a little about what we mean by humanizing science.

First, I remark on the eagerness with which we avail ourselves of this opportunity to help you, teachers of science in the secondary schools, to become acquainted with the institution. We know well enough that if ever our theories about the humanization of science are to be realized, the teachers of boys and girls must be a large, probably the largest, factor in doing it.

Despite the stupendous development of physical science in our day, there is wide-reaching, deep-seated misconception as to what science is; and this misconception is not confined to the laity. It pervades the fold of science itself. This assertion may surprise you; but I believe a little reflection will convince you of its truth. Being teachers, you do not need to be told that the curricula of practically all schools make the sharpest distinction, expressly or tacitly, between humanistic subjects and scientific subjects; between cultural and practical studies, science being the backbone of most of the practical courses. Have you ever known or heard of a school that considered its science courses to be cultural in a genuine sense? When "culture courses" are spoken of, are the scientific ones ever referred to? If so, it is only in the few instances where some science teacher of exceptional insight and personal force has driven his or her colleagues to accept such a valuation of subjects. So far as my observation has gone, admission of the culture-value of science that is not half-hearted and grudging is so rare as to be practically negligible. And a fact of grave concern is the tendency vocational training has to blindfold scientists and teachers of science into accepting this exclusively physical valuation of science. From this influence and others it happens that science has become the ally, and to a large extent the background, of that theory and practise in the civilization of our day variously spoken of as economism, industrialism, and commercialism. The monstrous power this theory of civilization has for destroying all that is finest and noblest and most cherished in human life is at last being recognized by certain thoughtful persons. But few there are, apparently, who yet see with clear vision the profound importance for the situation of beliefs touching the cultural value of science. One lot of philosophers take the ground that on the whole science is proving itself an enemy to mankind. They say the undeniable good science has done in providing man with more and better things to eat and wear, better dwellings, better means of communication, more abundant material wealth, greater immunity from disease, and so forth, are insufficient to offset the harm it does in robbing him of aspirations, ideals, faiths, sensitiveness to beauty in nature and in art, and love of his fellow beings. Just how numerous and influential these philosophers are, is difficult to estimate; but without doubt a sentiment of this kind is widespread in the community. It seems to have been growing during the last few decades; and the three-continent-wide struggle now raging is unquestionably helping it on. The dreadnaught service, the submarine service, the air-machine service, the giant artillery service, the poisonous-gas service, and the rest, are making evident to the whole world how efficient the several departments of Hell can be made by making them thoroughly scientific. "Poor science," said a writer for a Socialist paper the other day, "is too busy working in the service of militarism, perfecting instruments of destruction," to do much toward the advancement of civilization. I am sure science is less honored, less prized to-day, for any purpose not commercial or purely physical in some way, than it was when I was young; and to one aspect of the matter I would direct your special attention.

Beyond a doubt these later years have witnessed a flocking of people in increasing numbers to occult and mystical doctrines and practises of various sorts. Make the rounds of the bookshops in almost any city and you will find

writings of this character more numerously and conspicuously displayed than works on scientific subjects other than those of applied science and school text-books. Judging from the testimony of publishers and book-dealers, the public is finding little in modern science that satisfies the deepest needs of human life. I want to insist that a radical change will have to be wrought in the feeling of educated people generally toward science, if civilization is to rise much above its present level.

But estimation of the worth of science can be changed only as an incident to a profound change of conception of and feeling for nature. Let no one, especially no teacher of science, fail to make the sharpest distinction between *nature* and *science*—between nature itself and knowledge of nature!

I just mentioned *feeling* for nature. Here, I am persuaded, is the key to the situation. I wonder to what extent you have noted that the scientific authorities you read and meet rarely love nature. If they do, they rarely say so, or reveal their feeling in any way. In fact, it would be surprising if you have not been admonished by your leaders that *feeling* must be frozen out of science. With many a scientist the stigma that attaches to the phrase "nature lovers," from having been applied to a group of slop-overs has been extended to everybody who manifests love for nature in any way.

We touch a subject here too vast to do much with in a talk like this. I can only remark that practical experience and the psychology of feeling demonstrate the utter fallacy of the theory that science must be emotionless. Have you yourself or has anybody you ever saw or heard of, done thoroughly well any task into which the "whole heart," as we say, has not entered? But the "whole heart" is, as modern psychology is making us understand, the unerring folkway of saying that the feelings, the affective side of our natures, though not the intellect, must be ever present along with intellect in all high and effective endeavor. And I urge you to mark well this fact: The very men of science who depreciate love of nature do not hesitate to extol love of truth. Truth, they say, not only may be, but must be loved that its pursuit, even by science, shall be assured. We hear men preach love of truth and of emotionless science, almost in the same breath!

But what is truth? The query has beset all the sages of all the ages. Curiously enough, when you come to reflect, the sages who have sweated blood over this question have not been students of nature at all as modern science understands the phrase. The sages have looked at a few aspects of nature and have speculated endlessly and earnestly about nature; but they have not studied it.

Let a humble naturalist try his hand at defining truth. *Truth* (with as big a *T* as you please) *is all that has been learned plus all that remains to be learned about nature.* At the particular institution of scientific research which you visit to-day, the theory is held that nature and truth, while not identical, yet have so much in common—overlap each other in so much of their range—that whatever place *feeling* rightly has in the pursuit of the one, it has in the pursuit of the other. And here is the most vital spot of all: Men love truth because truth is to their advantage. It is beneficent—it makes goodness in their lives. Exactly so with nature according to our theory. Nature is beneficent. It is a maker of goodness in human lives. Indeed, excepting through nature, there is no goodness; and the chief end of science is to show in detail and literally how we live, move and have our being in nature. Through the achievements of modern medicine and hygiene and agriculture and industrial chemistry and mechanics, the most enlightened persons seem to have become convinced at last that nature is man's preserver and sustainer. It remains now for them to become convinced that nature is man's maker as well as his sustainer. This task falls more heavily on biology than on any other science.

So I ask that while you look over the "plant" of the Scripps Institution to-day and while you work toward a decision on whether or not you can accept the invitation we hope to extend to you before long to spend a little time at the institution next summer on some

work with us, you keep constantly before you the ideas and ideals of the institution here so sketchily described.

Wm. E. Ritter

La Jolla, Calif.

THE NATIONAL RESEARCH COUNCIL

On April 19, 1916, at the closing session of the annual meeting, the National Academy of Sciences voted unanimously to offer its services to the president of the United States in the interest of national preparedness. The council of the academy was authorized to execute the work in the event of the president's acceptance.

On April 26 the president of the academy, accompanied by Messrs. Conklin, Hale, Walcott and Woodward, was received at the White House by the president of the United States. In presenting the resolution adopted at the annual meeting, it was suggested that the academy might advantageously organize the scientific resources of educational and research institutions in the interest of national security and welfare. The president accepted this offer, and requested the academy to proceed at once to carry it into effect.

Immediately following this visit, the president of the academy, in harmony with resolutions adopted by the council on April 19, appointed the following organizing committee: Messrs. Edwin G. Conklin, Simon Flexner, Robert A. Millikan, Arthur A. Noyes and George E. Hale (*chairman*).

At a meeting of the council of the academy, held in New York on June 19, the organizing committee presented the following statement of work accomplished up to that date.

Much time was devoted during the first five weeks to the organization of committees to meet immediate needs, including those on Nitric Acid Supply (A. A. Noyes, chairman), in cooperation with the American Chemical Society; Preventive Medicine (Simon Flexner, chairman), in cooperation with the Committee of Physicians and Surgeons, and Synthetic Organic Chemistry (M. T. Bogert, chairman), in cooperation with the American Chemical Society. Special attention was also given to arrangements for cooperation with the scientific bureaus of the government, the committee of physicians and surgeons, the naval consulting board, the national societies devoted to branches of science in which committees were immediately needed, the national engineering societies, the larger research foundations, certain universities and schools of technology, and the leading investigators in many fields of research, both on the industrial and the educational side. The hearty encouragement received from all of these men and institutions leaves no doubt that, as soon as a general request for cooperation is sent out, it will meet with universal acceptance.

During this preliminary period a more comprehensive plan of organization was developed, and finally embodied in the form indicated below. It was recognized from the outset that the activities of the committee should not be confined to the promotion of researches bearing directly upon military problems, but that true preparedness would best result from the encouragement of every form of investigation, whether for military and industrial application, or for the advancement of knowledge without regard to its immediate practical bearing. The scheme of organization must be broad enough to secure the cooperation of all important agencies in accomplishing this result.

After considering a variety of plans the organizing committee presented to the Council of the Academy the following recommendations:

That there be formed a National Research Council, whose purpose shall be to bring into cooperation existing governmental, educational, industrial and other research organizations with the object of encouraging the investigation of natural phenomena, the increased use of scientific research in the development of American industries, the employment of scientific methods in strengthening the national defense, and such other applications of science as will promote the national security and welfare.

That the council be composed of leading American investigators and engineers, representing the Army, Navy, Smithsonian Institution and various scientific bureaus of the government; educational

institutions and research endowments; and the research divisions of industrial and manufacturing establishments.

That, in order to secure a thoroughly representative body, the members of the council be chosen in consultation with the presidents of the American Association for the Advancement of Science, the American Philosophical Society, the American Academy of Arts and Sciences, the American Association of University Professors, and the Association of American Universities; that representatives of industrial research be selected with the advice of the Presidents of the Society of Civil Engineers, the American Institute of Mining Engineers, the American Society of Mechanical Engineers, the American Society of Electrical Engineers, and the American Chemical Society, and that members of the cabinet be asked to name the representatives of the various departments of the government.

That research committees of two classes be appointed, as follows: (*a*) Central committees, representing various departments of science, comprised of leading authorities in each field, selected in consultation with the president of the corresponding national society. (*b*) Local committees in universities, colleges and other cooperating institutions engaged in scientific research.

The organizing committee also recommended the following plan of procedure, subject to such modifications as the National Research Council may deem desirable.

1. The preparation of a national inventory of equipment for research, of the men engaged in it, and of the lines of investigation pursued in cooperating government bureaus, educational institutions, research foundations and industrial research laboratories; this inventory to be prepared in harmony with any general plan adopted by the proposed government council of national defense.

2. The preparation of reports by special committees, suggesting important research problems and favorable opportunities for research in various departments of science.

3. The promotion of cooperation in research, with the object of securing increased efficiency; but with careful avoidance of any hampering control or interference with individual freedom and initiative.

4. Cooperation with educational institutions, by supporting their efforts to secure larger funds and more favorable conditions for the pursuit of research and for the training of students in the methods and spirit of investigation.

5. Cooperation with research foundations and other agencies desiring to secure a more effective use of funds available for investigation.

6. The encouragement in cooperating laboratories of researches designed to strengthen the national defense and to render the United States independent of foreign sources of supply liable to be affected by war.

The council of the academy voted to accept the proposals of the organizing committee, and instructed it to proceed with the formation of the National Research Council in accordance with the plan recommended by the committee.

In consultation with the presidents of the various societies already mentioned, most of the members of the council have now been chosen.

The endorsement of the president of the United States and the authority to secure the appointment of government representatives is conveyed in the following letter to the president of the academy:

WASHINGTON, D. C., July 24, 1916.

DR. WILLIAM H. WELCH,
President of the National Academy of Sciences, Baltimore, Maryland.

MY DEAR DR. WELCH:

I want to tell you with what gratification I have received the preliminary report of the National Research Council, which was formed at my request under the National Academy of Sciences. The outline of work there set forth and the evidences of remarkable progress towards the accomplishment of the object of the council are indeed gratifying. May I not take this occasion to say that the departments of the government are ready to cooperate in every way that may be required, and that the heads of the departments most immediately concerned are now, at my request, actively engaged in considering the best methods of cooperation.

Representatives of government bureas will be appointed as members of the Research Council as the council desires.

Cordially and sincerely yours,
[Signed] WOODROW WILSON

Under this authority, the appointment of representatives of the army, navy and various scientific bureaus of the government will now be arranged with the members of the cabinet.

It is expected that the first meeting of the council will be held in September.

It has already been stated that cordial desire to cooperate has been encountered on every hand. Special reference may now be made to certain striking cases. The first of these illustrates how the council, taking advantage of the increased appreciation of the value of science and the spirit of national service which have resulted from the war, may obtain the cooperation of educational institutions and assist them in adding to their endowments for scientific research. Throop College of Technology, in Pasadena, California, is a small institution of high standards which gives special attention to research. President Scherer, hearing of the plans of the research council, offered the assistance and cooperation of the recently endowed research laboratory of chemistry and secured at once an additional endowment of one hundred thousand dollars for scientific research. Under somewhat similar circumstances, a gift of $500,000 has been made to the endowment of the Massachusetts Institute of Technology, with the expectation that much of the income will be used for research at that institution.

Another illustration of friendly cooperation, of special importance because it assures the support of the national engineering societies, is afforded by the following resolution of the Engineering Foundation of New York, adopted at the annual meeting of the foundation, on June 21, 1916:

WHEREAS, the National Academy of Sciences of the United States of America has taken the initiative in bringing into cooperation existing governmental, educational, industrial and other research organizations with the object of encouraging the investigation of natural phenomena, the application of scientific principles in American industries, the employment of science in the national defense, and such other objects as will promote the national welfare, and

WHEREAS, these objects are among the objects for which The Engineering Foundation was created,

Now, Therefore, be it Resolved, that The Engineering Foundation hereby registers its approval of the coordination and federation of the research agencies of the country undertaken by the National Academy of Sciences and expresses its willingness to join with and assist the National Academy in accomplishing the above federation.

The foundation also offered to devote its entire income for the coming year (including a special gift of $5,000 for this purpose from its founder, Mr. Ambrose Swasey) toward the expenses of organization, and to provide a New York office for the council in the Engineers Building.

The presidents of the American Philosophical Society, of the American Association of University Professors, and of Yale University have already expressed their intention of proposing the adoption of similar resolutions by the institutions which they represent and of recommending the appointment of committees to cooperate with the National Research Council; and it is expected that other societies and educational institutions will take similar action.

Respectfully submitted by the organizing committee.

GEORGE E. HALE (*chairman*),
EDWIN G. CONKLIN,
SIMON FLEXNER,
ROBERT A. MILLIKAN,
ARTHUR A. NOYES

GEORGE E. HALE

A BRITISH BOARD OF SCIENCE AND INDUSTRY[1]

WE have received for publication from the British Science Guild the following memorandum on the relations which should exist in future between the state and science, and suggesting that a national statutory board of science and industry should be formed. The memorandum, which has been forwarded to the government, is signed by some 220 of the most important representatives of industry, science and education:

The British Science Guild, which was founded in 1905 with the object of bringing home to all classes "the necessity of applying the methods of science to all branches of human endeavor, and thus to further the progress and increase the welfare of the empire,"

[1] From *Nature*.

is of opinion that the present European crisis affords a unique opportunity for impressing upon all who are engaged in the executive functions of government, as well as upon those who are concerned with industry and commerce, the paramount importance of scientific method and research in national affairs.

There has been much discussion upon these matters, and the following conclusions are submitted by the Guild as representing authoritative opinion:

A. The material prosperity of the civilized world during the past century is mainly due to the application of science to practical ends.

B. While we stand high among all nations in capacity for original research, as represented by the output of our scientific workers, this capacity has been comparatively little utilized in British industry.

C. The state has neglected to encourage and facilitate scientific investigation, or to promote that cooperation between science and industry which is essential to national development.

D. Modern conditions of existence demand that instruction in science, and training in scientific method, should be a fundamental part of education.

E. The present control of all stages of educational work, from the primary school to the university, mostly by men who have an inadequate appreciation of the meaning and power of science, is largely responsible for the unsatisfactory preparation commonly provided for the work of life.

Since its foundation the British Science Guild has urged that, in the interests of national welfare, serious attention should be given to these defects, and steps taken to remedy them. The establishment of the scheme for the development of scientific and industrial research, under a committee of the Privy Council, is a welcome recognition of the intimate relations between scientific investigation and industrial advance; and the advisory council which advises the committee as to the expenditure of the sums provided by Parliament, amounting for the year 1916–17 to £40,000, has already been responsible for the institution of researches which should lead to most valuable industrial results. The outlook of the council may, however, be extended profitably in several directions; for it should be even more comprehensive than that of the development commission, which provides for the development of rural industries, among other matters. This commission, with the Board of Agriculture and Fisheries, and the Imperial Institute, which has recently been transferred from the Board of Trade to the Colonial Office, is not concerned directly with manufacturing industries, upon which so large a part of the nation's prosperity depends.

The field of the Privy Council committee and its advisory council is thus distinct from that of any existing state department; and it should embrace all progressive industry and science. It is suggested that a board or ministry is necessary to discharge the functions indicated in Clause I. of the recommendations subjoined, in such a way as to fulfil modern requirements.

I. A national statutory board of science and industry, the permanent staff of which should consist mainly of persons of wide scientific knowledge and business experience, should be established to:

1. Promote the coordination of industrial effort.

2. Secure cooperation between manufacturers and all available laboratories of research.

3. Coordinate, and be the executive center of such joint scientific committees as have been formed by the Royal Society, the Chemical Society and various trade and educational associations.

4. Undertake inquiries as to products and materials, and generally to serve as a national bureau of scientific and industrial intelligence.

5. Collect and publish information of a scientific and technical character; and provide so far as possible for the solution of important problems bearing upon industry.

6. Institute a number of paid advisory committees consisting of men of wide scientific knowledge assisted by expert investigators and technologists who should receive reasonable fees for their services.

7. Organize scientific effort on the manufacturing side and in commercial relations with other countries.

8. Arrange measures for the mobilization of the scientific, industrial and educational activities of the nation so as to ensure ready response to national needs and emergencies.

9. Encourage investigation, and, where necessary, give financial aid towards the synthesis and artificial production of natural products and for other researches.

Such a board would naturally administer the scheme of the Privy Council committee, as well as take over certain functions of existing departments and boards.

The functions of the board would be much the same as regards the promotion of scientific and industrial research and training, the cooperation of universities with industries through trade associations, and the maintenance of a record of scientific and technical experts, as outlined in the report on "British Trade after the War," by a subcommittee of the Board of Trade.

II. In all departments of state in which scientific work is carried on, adequate provision should be made for the periodical publication and wide distribution of bulletins, leaflets and reports, so that increased public interest and attention may be encouraged in the results.

III. Every industrial undertaking, subsidized or otherwise assisted by the state, should have upon its board of directors men who possess expert scientific knowledge of the business in which they are engaged.

IV. In order to develop industries which especially require the services of scientific workers, adequate remuneration and improved prospects should be offered by the government, by municipal corporations, and by manufacturers to men who have received an effective scientific training. Means should be found of compensating and rewarding persons whose researches have proved of decided national or public advantage without being profitable to themselves.

V. A knowledge of science should be regarded as an essential qualification for future appointments in the departments of the public service concerned with industrial, scientific and technical developments. The Royal Commission on the Civil Service recommended in 1914 that a committee should be appointed to consider the present syllabus of subjects of examination for clerkships (Class I.). This committee should be constituted without delay, and science as well as other branches of modern learning should be adequately represented upon it, and upon the Civil Service Commission itself.

VI. Measures should be taken to revise the educational courses now followed in the public schools and the universities of Oxford and Cambridge.

VII. In elementary and secondary schools supervised by the Board of Education, more attention should be given to scientific method, observation and experiment, and to educational handwork.

NEW YORK MEETING OF THE AMERICAN CHEMICAL SOCIETY

Official announcement of the meeting of the American Chemical Society, to be held in New York September 25 to 30, in conjunction with the Second National Exposition of Chemical Industries, was issued to the members by Dr. Charles L. Parsons, secretary, on August 15. Dr. Charles H. Herty, of the University of North Carolina, president of the American Chemical Society, will open the exposition on Monday, September 25, at 2 o'clock in the afternoon, with an address reviewing the history of chemistry and the chemical industries in this country, and outlining developments since the outbreak of war in Europe. The presidents of cooperating societies, such as the American Electrochemical Society, the American Institute of Mining Engineers, and the American Paper and Pulp Association, will follow Dr. Herty with speeches of welcome and reviewing the progress made in the industries represented by them.

The first general session of the American Chemical Society will open at Columbia University on Tuesday morning, September 26, and arrangements are being perfected for a public meeting in the large hall of the College of the City of New York on Tuesday afternoon, when addresses will be made of general public interest pertaining to the interesting developments in the field of applied chemistry during recent years.

The program of the week's meetings will provide for general conferences on subjects in which the chemists of the country are now interested, and it is intended that the lecture hall of the Grand Central Palace and Rumford Hall in the Chemists' Club building will be occupied each afternoon at the same time by one or other of the different divisions of the society for the discussion of such industrial topics as the production of dyestuffs, medicinal chemicals, industrial alcohol, the manufacture

of paper pulp and by-products, oils and motor fuels, glassware and porcelain, steel alloy metals, new developments in chemical industries, etc.

On Wednesday and Thursday mornings a general symposium on colloids will be held, theoretical considerations being discussed on the first day and the industrial applications of colloid chemistry on the second day.

The American Electrochemical Society has planned a series of interesting meetings. The electrochemical group will open its meeting later in the week, on Thursday, September 28, with a technical session devoted to a review of American progress in the electrochemical industry. A complimentary smoker will be held on Thursday evening, and on Friday evening there will be a joint banquet at the Waldorf-Astoria of the members of the American Chemical Society, the American Electrochemical Society, and the Technical Association of the Pulp and Paper Industry.

SCIENTIFIC NOTES AND NEWS

THE funeral of Sir William Ramsay took place at Hazlemere, High Wycombe, on Wednesday, July 26, in the presence of representatives of the Royal Society, the Chemical Society, University College, London, and many other societies and institutions.

GENERAL WILLIAM C. GORGAS, U. S. A., head of the yellow fever commission of the International Health Board of the Rockefeller Foundation, arrived at Bogota, Colombia, from Panama, on August 9. General Gorgas will consult with the Colombian government on sanitary conditions of ports in that country.

PART of the Canadian Arctic expedition, which is led by Vilhjalmur Stefansson, has returned to Nome, Alaska, after spending three years in investigations on the north coast of Canada. Dr. Anderson, of the southern party, reports that Stefannson may not return until some time in 1918. He planned to start from winter quarters in May last to continue his explorations of the new land west of Prince Patrick Island.

THE Astley Cooper prize for the present year, for a treatise on "The Physiology and Pathology of the Pituitary Body," has been awarded to Dr. W. Blair Bell, of Liverpool.

MR. JAMES MOONEY, of the Bureau of American Ethnology has been in North Carolina to continue his researches among the Cherokee Indians.

DR. LEO J. FRACHTENBERG, who has been in the field for the Bureau of American Ethnology for the past year, has changed his headquarters to Portland, Oregon.

MR. C. B. WILLIAMS has been appointed by the Board of Agriculture, Trinidad, to study the parasites of the sugar-cane froghopper in that island.

M. C. WHITAKER, professor of chemical engineering, Columbia University, has been granted leave of absence for the first term of the academic year, 1916–17.

PROFESSOR W. S. MILLER, of the department of anatomy at the University of Wisconsin, has been giving a series of illustrated lectures before the Robert Koch Society for the Study of Tuberculosis, at Chicago, on "The Lymphatics and Lymphoid Tissue of the Lung and their Relation to Disease Processes," and an illustrated lecture before the Cincinnati Research Society on "The Anatomy of the Lungs with special reference to the Lymphatics."

THE Eugenics Education Society of Chicago holds its meetings once a month. Special speakers at these meetings during the current year have been Professor James A. Field, Professor John M. Coulter, Professor Frank R. Lillie, Professor Frederick Starr, Dr. Albert J. Ochsner, Alexander Johnson and Professor Judson Herrick.

WE learn from *Nature* that on Wednesday, July 26, the memorial to Sir William White, promoted by the Institution of Naval Architects, was formally handed over to the council of the Institution of Civil Engineers. The presentation was made by Admiral Sir Reginald Custance and Earl Brassey, who stated that £3,000 had been collected. The money is to be allotted to the foundation of a research scholarship fund, the provision of a memorial medallion to be placed in the hall of

the Institution of Civil Engineers, and a grant to Westminster Hospital. The memorial was accepted by Mr. Alexander Ross, the president of the Institution of Civil Engineers, and now occupies a position on the right hand of the entrance hall. The medallion consists of a portrait of Sir William, carved in relief in white stone, with a warship visible in the distance. The carving is mounted on grey marble, and carries underneath it a tablet, on which are inscribed the words: "Sir William Henry White, K.C.B., LL.D., D.Sc., F.R.S., President, 1903–1904, Director of Naval Construction, 1885–1902. A Tribute from the Shipbuilders of Many Nations." Above is a scroll bearing the motto, "Build Staunch, Build True."

George Anthony Hill, at one time assistant professor of physics in Harvard University, the author of a number of text-books in physics and mathematics, died on August 17, aged seventy-four years.

John P. D. John, at one time professor of mathematics and astronomy in DePauw University and later president of the institution, died on August 7, at the age of seventy-three years.

Johannes Ranke, professor of anthropology at Munich, has died aged eighty years.

Sir William Henry Power, F.R.S., distinguished for his contributions to sanitation and public health, died on July 28, aged seventy-four years.

Rowland Trimen, F.R.S., formerly curator of the South African Museum, author of works on the butterflies of South Africa, died on July 25, at the age of seventy-six years.

Edgar H. Harper, professor of mathematical physics in University College, Cork, known for his work on aviation, has been killed while serving as lieutenant.

F. W. Caton, for a time connected with the Welcome Chemical Research Laboratory, and later lecturer on chemistry and inspector under the Staffordshire Educational Committee, was killed on June 28, while serving as second lieutenant in the British army.

Geoffrey W. Smith, fellow of New College, Oxford, captain in the British Army, has been killed in France. Dr. Alfred G. Mayer writes: "In his death biology loses one of its ablest students, his researches upon the effects produced by parasites upon the secondary sexual characters of crustacea being a classic of science. He was among the first of the university men to enter the service of his nation, and in a letter to me he expressed his regret at leaving his studies, but 'England had need of many junior officers and many of these must be killed, so I must go as soon as possible.' High as his scientific attainments were, few men have been endowed with the rare charm of personality he possessed, and thus doubly must we mourn him."

The Susquehanna River Archeological Expedition, in charge of Messrs. W. K. Moorehead, Alanson Skinner and George P. Donehoo, finished its work on August 1. The party consisted of nine men, and began work at the head of the river, Otsego Lake, New York state. A preliminary survey was made of the entire river, from its source to Chesapeake Bay. Local students and collectors cooperated with the expedition at various points. The party examined a large number of sites along the Susquehanna, and exposed ancient villages attributed to the Delaware, Shawnee, Iroquois and Andaste Indians. A collection of several thousand specimens was secured for the Museum of the American Indian, Heye Foundation. The most important discovery during the journey was the location and excavation of an Andaste cemetery, near Athens, Pennsylvania, where fifty-seven skeletons were unearthed, with interesting specimens of Iroquoian pottery, pipes and stone implements. Contrary to absurd newspaper reports, none of the skeletons were abnormal, nor were they found in a mound. One of the burials, of the so-called "bundle" type, was of unusual interest, since it was covered by a deposit of the antlers of the Virginia deer.

The annual general meeting of the Society of Chemical Industry was held in Edinburgh on July 19–21. According to the account in *Nature*, the meeting this year took the form

of a congress on the progress made since the outbreak of war in British chemical industry. The following papers were read and discussed: (1) *Fuel.*—Fuel economy: a national policy required, Professor H. E. Armstrong; Some recent improvements in coke works practise, Dr. G. P. Lishman; Waste in coal production, Professor H. Louis. (2) *Shale Oil.*—The shale oil industry, D. R. Steuart. (3) *Tar Distilling.*—A short review of the influence exerted by the war on the tar distilling industry, W. H. Coleman; The extraction of tar fog from hot gas, G. T. Purves. (4) *Dyes.*—The difficulties of coal-tar color-making in war-time, C. M. Whittaker (British Dyes, Ltd.). (5) *Fine Chemicals.*—Notes on the production of alkaloids as affected by the war, D. B. Dott; The manufacture of synthetic organic drugs as affected by the war, F. H. Carr; The manufacture of fine chemicals in relation to British chemical industry, C. A. Hill and T. D. Morson. (6) *Paper-making.*—The paper-mill chemist in war-time, J. F. Briggs. (7) *Patent Law.*—The overhauling of our Patent Law, J. W. Gordon; The influence of the Patent Laws upon industry, W. F. Reid; Proposed amendments to English Patent Law, W. P. Thompson. (8) *Rare Earths.*—The progress of British rare-earth industry during the war, S. J. Johnstone. To illustrate the progress that has been made, an exhibition was held, at the same time, of specimens of British-made coal-tar dyes, glass, porcelain and filter paper, along with several other interesting substances now made in Edinburgh. Among these may be mentioned cobalt-blue—a substance never before manufactured in this country—now made by the Beaverhall Color Co.; trinitrotoluene by the Lothian Chemical Co.; erasers, etc., manufactured by the North British Rubber Co., the supply of which formerly was entirely imported from Germany.

The recovery of the valuable by-products from American coke manufacture made big advances in 1915 and has now attained the proportions of an important industry. The value of these by-products last year was nearly $30,000,000, a large increase over the previous high-water mark of $17,500,000 in 1914. Although there were material increases in the output and value of gas, tar and ammonia, which was to be expected with a greater output of by-product coke, the increase in benzol products was remarkable and presented the most interesting feature of the year in the coke industry. The value of these products rose from less than $1,000,000 in 1914 to more than $7,760,000 in 1915, according to C. E. Lesher, of the United States Geological Survey, Department of the Interior. Benzol has been recovered in this country from coke-oven gas for a number of years, but prior to 1915 the market was small and the prices low. The awakening of the American people to the need for a dye industry and to a realization that such an industry can not spring full-grown from nothing but must be fostered and developed is now a well-known story. Few are aware, however, of the progress that has been made within a year in laying the foundations for future progress in that industry. Under the spur of almost fabulous prices for benzol products, retort coke-oven plants throughout the country quickly installed elaborate benzol-recovery systems and now save the valuable oils that not very long ago were being buried or wasted, or, if saved, were begging for a market. The benzol products obtained in 1915 amounted to 16,600,657 gallons. More than 13,000,000 gallons of the total output was reported as crude light oil and had an average value of 33 cents. Some of the plants have their own stills and refineries, and the pure benzol reported from those sources amounted to 2,516,483 gallons, with an average value of nearly 57 cents, at least three times the value of crude benzol before the war, and 623,506 gallons of toluol, with an average value of $2.45 a gallon. Crude benzol, which in 1914 was used to some extent for motor fuel, contained the toluol, which is now separated out and sold at fancy prices. More than 138,000,000 gallons of tar was obtained from coke ovens and sold for $3,568,384 in 1915. The ammonia, of which nearly 100,000 tons was reported as sulphate and the remainder as liquor (10,626,612 gallons) and anhydrous ammonia (30,002,196) pounds), brought a total of $9,867,475 to the producers.

Surplus gas to the extent of 84,356,000,000 cubic feet, valued at $8,625,000, was sold or used. Of that quantity 17,196,000,000 feet was used as illuminating gas, 27,591,000,000 feet as domestic fuel, and 39,569,000,000 feet as fuel for steam raising, open-hearth furnaces, gas engines, and other industrial purposes. These by-products, which had a total value of $29,824,579, were obtained by the carbonization of 19,500,000 tons of coal, from which was also obtained 14,000,000 tons of coke, valued at $48,500,000. The total value of the coke and by-products was more than $78,300,000.

THE production of bituminous coal and anthracite in the United States in 1915 amounted to 531,619,487 short tons, valued at $686,691,186, an increase, compared with 1914, of 18,094,010 tons or 3.5 per cent., in quantity, and of $5,200,543, or 0.8 per cent., in value, according to C. E. Lesher, of the United States Geological Survey. Of this total output, 442,624,426 short tons, valued at $502,037,688, was bituminous coal and lignite, and 88,995,061 tons, valued at $184,653,498, was Pennsylvania anthracite. Pennsylvania, with an output of 157,955,137 tons of bituminous coal and 88,995,061 short tons of anthracite, ranks first among the coal-producing states. West Virginia, with a production of 77,184,069 tons; Illinois, with 58,829,576 tons; Ohio, with 22,434,691 tons, and Kentucky, with 21,361,674 tons, follow in order of production. Thirty states and the territory of Alaska contributed to the total, of which number 13 states and Alaska had increased production, and 17 had decreased production, compared with 1914. To produce this coal, 734,008 men were employed for an average of 209 days.

THE second Interstate Cereal Conference will be held at the University of Minnesota, University Farm, St. Paul, July 11, 12 and 13. At this conference there will be a discussion of the various phases of cereal research relating to the region of which St. Paul may be considered the center. The program will include papers on problems of wheat, oats, barley and flax production in the Northwest; the grading of barley and corn; breeding winter wheats for Minnesota; ergot of rye; methods for the eradication of bunt or stinking smut; problems in flax diseases, and a symposium on milling and baking. Two days will be devoted to the presentation and discussion of papers. The third day will be used in an inspection of the plant work of the Minnesota Agricultural Experiment Station and of one of the local flour mills.

RECEIPTS from national forests for the fiscal year 1916 reached the high-water mark of approximately $2,820,000, according to figures just compiled. This is $341,000 above the 1915 total, which in turn exceeded any previous year. Officials say that the gain was due to increased demand for all classes of forest products. There was a decided growth in the revenue from all sources, the largest being that of $203,000 in timber sales. Grazing fees showed a gain of $77,000. Receipts for water power development were over $12,000 more than for 1915. Sales of turpentine privileges and charges for special uses were both considerably in excess of the previous year. The National forests are important factors in the prosperity of the regions in which they are located, on account of the large amounts of timber, range and other resources which they hold available for use as needed. Business conditions are reflected in the receipts of the forests. Consequently the showing for the past year is regarded as an index of increased business activity throughout the sections where the national forests are found.

UNIVERSITY AND EDUCATIONAL NEWS

COLUMBIA UNIVERSITY has received $100,000 from Mr. James N. Jarvie, the banker, for the new dental school, plans for which were announced last spring.

THE Municipal University of Akron is about to erect an engineering laboratory at the cost of $50,000, provided by a bond issue of the city. The new library building, erected at a cost of $40,000, is now open for use.

PRINCETON UNIVERSITY announces that October 26 has been set aside as the day for the laying of the corner stone of the handsome new student dining halls, now being erected at the corner of Nassau Street and University

Place. The dining quarters and the kitchens will be far enough advanced to accommodate the number of undergraduates who formerly took their meals at "Commons," comprising about one thousand students.

DR. WALTER A. JESSUP, dean of the college of education at the State University of Iowa, has been elected president of the university, to succeed Dr. Thomas H. Macbride, the botanist, who retires at the age of sixty-eight years.

HOWARD C. PARMALEE, of Denver, has been elected president of the Colorado State School of Mines at Golden.

AT Dartmouth College, Charles N. Haskins has been promoted to be professor of mathematics on the Chandler foundation, Norman E. Gilbert has been promoted to be associate professor of physics and Arthur B. Meservey to be assistant professor of physics. Carl C. Forsaith has been appointed instructor in biology.

W. S. MILLER, of the department of anatomy, at the University of Wisconsin, has been promoted from associate professor to professor of anatomy.

STANLEY C. BALL, Ph.D. (Yale, '15) has been appointed instructor in zoology in the Massachusetts Agricultural College. Frank N. Blanchard (Tufts, '13) has resigned from the department in order to enter the graduate school of the University of Michigan.

DR. T. G. MOORHEAD has been elected professor of the practise of medicine in the School of the Royal College of Surgeons in Ireland, in the place of Sir John Moore, who has retired.

DISCUSSION AND CORRESPONDENCE

NORTH AMERICAN FAUNAL AREAS

A VERY interesting discussion of the geographical distribution of the fresh-water faunas of North America[1] has recently been published by Mr. Louis Germain. This author reviews the works on this subject by American authors in a very able manner and the paper is a valuable contribution to the literature of this subject. There are several statements, however, which probably will not be accepted by all American zoologists. Germain accepts Simpson's[2] division of the continent into the Pacific, Atlantic and Mississippian regions as representing the best and only natural division into faunistic areas. The subdivisions by Dall[3] and Baker[4] are believed to be too complex; and the latter author is criticized for establishing so complex a subdivision of the territory based on the data supplied (apparently) by a single small division of animals. But the facts are that the map on page 57 of the Lymnæa monograph was made not only from data furnished by the Lymnæas, but also by all of the families of basommatophorous mollusks, *Planorbis, Physa,* etc., the data for which was secured while working upon the Lymnæid monograph. Not only, however, do the families of Basommatophora fit into this detailed scheme, but it is quite possible that all of the fresh-water mollusks, gastropods as well as pelecypods, may be included. The Amnicolidæ, Pleuroceridæ and Viviparidæ, as well as the great Unionidæ family, have many groups of species which are confined to some one of the divisions indicated by the map in question.

As the writer has already stated in the Lymnæa monograph, the distribution of fresh-water mollusks, or for that matter of any fresh-water group of animals, can be understood only by a study of the river systems, past and present. It is more frequently the natural divides separating river drainages that form the boundaries of faunal areas rather than the presence of mountain chains, which indeed do not always afford a barrier, but a means of communication, as, for example, Two Ocean Pass in Wyoming, at the summit of the continental divide, where the head waters of the

[1] "L'Origine et la Distribution Géographique des Faunas d'eau Douce de L'Amérique du Nord," *Annales de Géographie,* No. 32, XXIII–XXIV. année, pp. 394–406, 1915.

[2] C. T. Simpson, "Synopsis of Naiades," p. 505.

[3] W. H. Dall, "Land and Fresh-water Mollusks of Alaska," p. 1.

[4] F. C. Baker, "Lymnæidæ of North and Middle America," p. 56.

Yellowstone and Snake rivers mingle during the wet season and afford a means by which fresh-water animals have crossed from one drainage to the other. The dispersal of all fresh-water forms has been normally by means of the changes in river systems, the fauna following up the river as the head waters of the latter work their way into new territory. Frequently, ancient changes in streams, incident to piracy or beheading, etc., may be known long afterward by the peculiarities of the fauna inhabiting the present river system, indicating many times that the present system is made up of several ancient systems. A case in point is the Tennessee River system which has been shown by C. C. Adams,[5] from a study of the distribution of the molluscan genus *Io*, to be made up of several smaller systems once separated by divides. Ortmann's studies on the Unionidæ and the crayfishes also bring out the value of distributional areas by river systems. The peculiar physical changes in the Ohio River previous to and following the glacial period, will doubtless be reflected in the fauna, both recent and extinct, when detailed studies are made bearing on this subject.

The point which the writer wishes to bring out and emphasize is that while it is true that there are the three primary divisions as indicated by Simpson and so strongly advocated by Germain, there are also in addition many smaller divisions which form precise faunal areas just as true and natural as the three major areas. The true relation of the different fresh-water faunas can only be determined by dividing the continent into areas separated by natural water partings, as has been done by Dr. Dall and the writer. That too many divisions have been made by the writer in his Lymnæa monograph may be true and is to be expected in a first attempt, but the method is the only satisfactory one for the study of fluviatile animals, a statement in which I am sure all American students will agree. Studies from this standpoint, however, have not yet been made in sufficient number and detail to work out a comprehensive scheme of subdivision. It was with a view to stimulating such studies that the map in question was published.

Germain (page 397) criticizes the author for his statement (page 84) that "It is not believed by the writer that the supposed land connection with Europe via Greenland contributed to any extent in the formation of the present Lymnæid fauna," and states that it is dangerous to base a general conclusion on a particular case. The statement was not based on the Lymnæidæ alone, but on the whole Basommatophorous group, the exotic species of which, from the data at present known, seems to have reached America by way of Alaska rather than by the Greenland connection. The absence of such striking forms as *Lymnæa stagnalis*, *Galba palustris* and *Aplexa hypnorum* from the Greenland fauna and their presence in the Alaska fauna is tangible evidence, to say the least. It is of course possible that this condition is due to a lack of sufficient detailed field work in northeastern America, but until this has brought to light the missing data the deductions must remain as based on present information. The invasion from Siberia was evidently contemporaneous with that of the larger mammals which occurred in the late tertiaries. The northeastern land connection is thought to have been used by several mollusks (Margaritana and some helices) and it would be strange indeed if some fresh-water mollusks of other groups did not also take advantage of the land bridge. However, in this as in other things the deductions must be based on the available facts and not on theories. The discovery of the European land snail *Tachea hortensis* in Pleistocene deposits[6] goes a long way toward establishing the existence of a northeastern land connection in late Tertiary time.

The critical study of the fresh-water faunas of many states and the ecological work of several universities is providing a mass of data which will ultimately afford the material for a satisfactory division of North America into natural faunal areas. It is quite possible, however, that it will be difficult to establish a system that will include both fresh-water and ter-

[5] National Academy Sciences, Memoir XII., No. 2, 1915.

[6] C. W. Johnson, *Nautilus*, XX., p. 73, 1906.

restrial species, the methods of dispersal being different in the two classes of animals.

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"SAME"—EDUCATIONAL EXPERIMENT STATIONS

To the Editor of Science: I have read with much interest the bill of Senator Newlands for the establishment of engineering experiment stations and heartily approve "same."

It is especially gratifying to note that bulletins giving results of investigations "shall be sent to persons, newspapers, institutions and libraries . . . as may request same" (Sec. 3, Science, p. 891).

In connection with "same" it is interesting to note that the use of the word "same" without "the" before it, which formerly was considered a sign of illiteracy, has now so far become customary that it may be allowed in a bill introduced in the Senate of the United States, and that both "same" and "as" may be used as relative pronouns.

The bill for the establishment of engineering experiment stations should be passed, after it has been improved by the Senate's grammatical censor. It is to be hoped that some day in the near future another bill will be introduced in the Senate for the establishment of one or more Educational Experiment Stations. The government, through its Agricultural Experiment Stations teaches the farmer how to raise crops; through its Bureau of Mines it teaches the mine owners how to mine coal and to avoid wastes of property and of life; should it not have Educational Experiment Stations to teach our schools and colleges how to avoid educational wastes?

Wm. Kent

SCIENCE AND WAR

To the Editor of Science: The Boston Sunday *Herald* prints a feature called "Herbert Kaufman's Weekly Page." It must be popular, though the writer has never heard it quoted—in contrast to this paper's apotheosis of American wit, the "Line o' type." The page is a collection of moral sentiments in a form to which no one can deny a frequent force and picturesqueness. Its dominant appeal is emotional. A few issues since it contained an appreciation of science running in part as follows:

> For half a century we have liberally endowed, supported and encouraged the scientists. Community funds paid for the institutions in which they were educated and underwrote their experiments.
>
> And all the while, we believed that these endeavors were promotions in the interest of civilization. . . .
>
> To-day we stand horror-stricken before the evidence of inhumanities only made possible through scientific advancement. . . .
>
> Chemistry, you stand indicted and shamed before the Bar of History! . . .
>
> You have prostituted your genius to fell and ogrish devices. . . .
>
> You have turned killer and run with the wolf-pack.
>
> But we will reckon with you in the end.

We can probably agree with Mr. Kaufman that science has increased the amount of suffering that war inflicts. No account need be taken here of the questions if this is due to science or human nature, and if the compensations are not sufficient; the second because it admits an endless argument, and the first, of none. The issue boils down to whether, if the encouragement of science on the broad lines of the past were abandoned, the horrors of war would be proportionately lessened.

This would be conceivably so if it were humanly possible to restrict scientific work to lines of no value for warfare. But success in war is as keenly desired as ever, and it is the part now of every prudent nation to equip itself in the best practicable manner for carrying it on. The writer has elsewhere remarked on the commonplace that victory is not to the side that can exert the strongest physical force with its own bodies but which can most intelligently direct the forces of nature. If the total amount of scientific work were thus restricted the human result would be to concentrate the work of science more and more upon warlike matters with a consequently increased social suggestion of war. A liberal encouragement of scientific progress serves to diffuse men's energies over other and more peaceful interests. To blame chemistry for the horrors of

war is a little like blaming astronomy for nocturnal crime. It is better to keep the bellicose applications of science as its incidental products rather than the chief ones they would become under those elements of human nature that must also be "reckoned with" in the end.

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QUOTATIONS

SCIENTIFIC APPOINTMENTS UNDER THE GOVERNMENT

A scientific journal must avoid the discussion of party politics, but it is legitimate to point out that the two leading parties have adopted platforms which, as far as their principles go, might almost be interchanged, and have nominated candidates who have much in common, both of them being lawyers, university professors and sons of clergymen. In view of these circumstances it is of interest to those concerned with science that Mr. Hughes in his first campaign speeches should select as one of his two leading issues the appointments by President Wilson to scientific offices under the government. This would not have been a vital political issue a few years ago, and it is certainly gratifying that it should now have become so, more especially as both parties and both candidates profess the same desirable principles and only dispute about the extent to which they have been maintained.

In opening his campaign at Detroit, Mr. Hughes charged the administration with having displaced the scientific heads of the census and of the coast and geodetic survey with men not having scientific qualifications. The word "displaced" is ambiguous and was perhaps intended to be so, and the reply of the secretary of commerce that both men had "voluntarily retired" is also, and it may be purposely, ambiguous. Men familiar with university affairs, like the two candidates for the presidency, know that professors sometimes have their resignations presented to them. It is allowable to say either that Dr. Wilson displaced Dr. Patten as president of Princeton University or that Dr. Patten resigned and was succeeded by Dr. Wilson. As a matter of fact, Dr. Durand's resignation as director of the census was forced, and Dr. Tittman, who was sixty-five years old and in indifferent health, resigned voluntarily from the Coast and Geodetic Survey.

The vulnerable point in the action of the administration is the appointment of their successors. Mr. William J. Harris, appointed director of the census, was chairman of the democratic state committee of Georgia and the appointment appears to have been for political reasons, as has unfortunately so often happened in the bureau of the census, where the extension of civil service rules has been least adequate. E. Lester Jones, when appointed superintendent of the coast and geodetic survey to succeed Dr. Tittman, was deputy commissioner of fisheries. His appointment to that office and his promotion to the head of the survey in the same department appear to have been personal rather than political. He has proved to be an efficient executive, but his appointment to both offices certainly violated the principle that these positions should be held by experts.

It can not, however, be denied that there are two sides to this question. Under modern conditions a distinguished man of science is likely to be a good executive, but the number of scientific men available for a position of this character is limited, and it is by no means certain that it is desirable to divert the skilled expert from his research work to an executive position. Another solution of the problem would be to make the heads of bureaus purely administrative officers, to be filled by men used to administrative work, but for the scientific policy of the bureau to be decided by a committee of its scientific experts and for the more eminent of these to receive salaries not smaller than that of the executive head.

Mr. Hughes has not pointed out, as an impartial judge might have done, that the two scientific appointments mentioned are the only ones in which the president is open to criticism, or that he is the first president who has officially asked the advice of scientific men on such points. At the meeting of the council of the American Association for the Advance-

ment of Science, held in Washington on April 22, 1913, shortly after President Wilson's installation, the following resolution, proposed by Mr. Cattell, was passed:

WHEREAS, It is eminently desirable that scientific men especially skilled in their departments be appointed as heads of the scientific bureaus of the government, therefore,

Resolved, That a committee of three be appointed to communicate to the President of the United States that it is the opinion of the council of the American Association for the Advancement of Science that a scientific man skilled in meteorology should be selected as the Chief of the Weather Bureau.

The committee waited on the president who requested the secretary of agriculture to consult with the committee of the association. The secretary of agriculture at that time stated that no appointment in the department of agriculture had been made or would be made for political reasons, or even be given to a man who sought the office. The committee of the American Association called the attention of the secretary to the fact that the National Academy of Sciences is by law the scientific adviser of the government, and the president, as far as we are aware for the first time since the law was enacted in 1863, asked the advice of the academy on an appointment. A committee of experts of the academy recommended three men skilled in meteorology and fitted for the office of chief of the Weather Bureau, and one of these was appointed by the president. In like manner the commissioner of fisheries was appointed from candidates proposed by the American Society of Naturalists and the American Zoological Society. In other cases President Wilson has asked and followed the advice of scientific bodies and scientific men, and his record in this respect is certainly better than that of any of his recent predecessors. We can only hope that he himself or Mr. Hughes, as the case may be, will still further improve this record in the course of the next four years.—*The Scientific Monthly*.

PRESIDENT WILSON'S SCIENTIFIC APPOINTMENTS

CANDIDATE HUGHES has publicly charged President Wilson with having made appointments to scientific departments of the government without consideration of the scientific fitness of the appointees and to the detriment of the public service. The charge is so unfair and untrue that it deserves to be repudiated by all who know the facts with regard to any of these appointments, as it has been denounced already by Secretary Redfield and Acting Secretary Sweet with respect to the superintendent of the Coast and Geodetic Survey.

The fact is that no president within recent years at least has taken so much pains to obtain the advice of scientific societies and of scientific men regarding appointments to scientific positions within the government; and none has more faithfully followed that advice, as is shown, for example, in his appointment of the present commissioner of fisheries, the chief of the Weather Bureau, the chief chemist of the Department of Agriculture, etc.

The contrast between President Wilson's attitude in this respect and that of some of his predecessors is very striking. In 1898 the American Society of Naturalists and the American Society of Zoologists appointed a committee to wait upon President McKinley and urge him to appoint as commissioner of fisheries some trained scientific man who should have a practical knowledge of the fish and fisheries of our coasts. President McKinley told the committee that he was not free to consider their recommendation since the place had already been promised to one who, as it turned out, was not scientifically trained and whose only known qualification was that he was a deserving Republican.

In 1913 the same societies passed a similar resolution and sent a similar committee to President-elect Wilson upon the same subject. Mr. Wilson thanked the committee for bringing the matter to his attention and asked for recommendations of persons for the position. The committee considered the matter carefully and after consulting with various members of the societies and with others interested in our fisheries recommended three persons in order of preference and, although it is known that much pressure was brought to bear upon Pres-

ident Wilson to continue the custom of his immediate predecessors of appointing the commissioner of fisheries for partisan rather than for public services, he appointed the man who stood first in the committee's recommendations.

Again, in appointing the chief of the Weather Bureau, President Wilson took unusual means to secure the best available man by requesting the National Academy of Sciences to recommend a suitable person for the position. Although the Academy was established by Act of Congress in 1863 to serve as adviser to the government in matters of science, and although since that time it has had among its members the most distinguished scientific men in America, this was the first time that a president of the United States ever asked the Academy for advice as to a scientific appointment. Also, in the selection of the chief chemist of the Department of Agriculture and of the chief of the Bureau of Mines, the president sought and acted upon the best scientific advice which he could get. In no one of these cases did he inquire about the political affiliation of the person recommended.

In many other matters President Wilson has shown an unusual and unprecedented desire to consult the leading scientific bodies of this country on subjects of science and a marked degree of independence in following their advice, sometimes in spite of much political or personal opposition. Through his individual action the question of the best means of abating the slides at Panama was referred to the National Academy of Sciences, and at his request a committee was appointed to investigate and report upon this subject; the names of the committee were a sufficient guarantee that their work would be well done, and their report, which was promptly made, will probably be of inestimable value to the nation. Quite recently the President requested the National Academy of Sciences to take the initiative in bringing into cooperation existing governmental, educational, industrial and other research organizations with the object of promoting national welfare and of providing for national defense. As a result there has been established through the cooperation of national scientific societies, research institutes, universities and the scientific departments of the government a National Research Council, as described by Dr. George E. Hale in a letter to *The Times* on August 1, which should be of great and lasting value to this nation.

Under these circumstances it does not seem fitting that scientific men should allow to go unchallenged the statement that the scientific work of the government has been degraded by President Wilson's appointments or the implication that his interest in that work has been that of a partisan.—*Edwin G. Conklin of Princeton University in the New York Times.*

SCIENTIFIC BOOKS

Analytical Mechanics. By H. M. DADOURIAN, M.A., Ph.D. Second edition, revised and enlarged.

In his second edition of his "Analytical Mechanics," Dr. Dadourian has made a number of changes and additions. What he assumes as the fundamental principle of mechanics he now calls the "Action Principle" which is a modified form of what he formerly called "The Principle of Action and Reaction." "A new chapter has been added which is devoted to the equilibrium of framed structures and graphic statics." "The number of diagrams has been increased by one hundred and thirty, and about three hundred practical problems have been added." Other smaller changes have been made. In all the book has been enlarged by about seventy additional pages.

In his first edition, the author states that the book "is based upon a course of lectures and recitations which the author has given during the last few years to the junior class of the electrical department of the Sheffield Scientific School." "In order to make the book suitable for the purposes of more than one class of students a larger number of special topics are discussed than any one class will probably take up. But these are so arranged as to permit the omission of one or more without breaking the logical continuity

of the subject." "The historical order of the development of mechanics is followed by discussing equilibrium before motion."

The author certainly has given considerable thought to the preparation of his book, which contains some very interesting matter. In the large collection of problems he gives, there will be found some very interesting ones. The reviewer himself was sufficiently interested to think out solutions for a number of them.

The plan of the book is certainly unique in a number of ways. This is not necessarily a criticism. There is a wide feeling that text-books in mechanics written for our engineering students fail to interest the students as they ought to do, and it may be that that book that will be found most satisfactory will be written according to a plan that will be quite unique when compared with the plans in accordance with which our present standard text-books on mechanics are written. The reviewer of this particular text-book is unable to appreciate, however, the author's point of view of some parts of his book.

In the first place, the author devotes his first chapter (of 11 pages) to "Addition and Resolution of Vectors." After that he merely states that a quantity has magnitude and direction and that, therefore, it is a vector. In the composition and resolution of such quantities, he then uses the law of addition and resolution of vectors as developed in his first chapter. This makes everything easy, at least as far as the author is concerned. For instance, the composition of couples reduces itself to this: "The resultant of two couples is a third couple whose torque is the vector sum of the torques of the given couples." That is all that need be said concerning the composition of couples. Similarly for the composition of the other directed quantities.

The reviewer does not wish to criticize this mode of procedure but wishes to ask if this mode of procedure is legitimate. Vector addition is simply one of the operations in an algebra in which the parallelogram law is made one of the fundamental assumptions. Before we apply the law of vector addition to any kind of quantity, ought we not first assure ourselves that the parallelogram law holds for these quantities? Since force, for instance, is a directed quantity, does it follow that the parallelogram law holds for forces? The same may be said of other directed quantities. Vector representation of directed quantities is very important and useful, and vector addition and resolution should be given, but it should be given only after we are assured that the parallelogram law holds with reference to such quantities. If the author is correct in reversing this process, then certainly the theory underlying the composition and resolution of directed quantities becomes very simple.

In the second place, the author's plan is unique in that he takes the following principle as the foundation of his book: "The vector sum of all the external actions to which a system of particles or any part of it is subject at any instant vanishes." This principle he calls the "action principle." To understand what the author means by this principle, we must understand what he means by "action."

On page 15, the author states that "all actions to which a particle is capable of being subject may be divided in two classes, namely, *forces* and *kinetic reactions*." He then defines force as the action of one particle upon another. On page 17, he states that kinetic reaction represents the action of the ether on a particle and that it equals the product of the mass of the particle by its acceleration. That is, if q is this kinetic reaction then $q = -ma$. The negative sign is used since the direction of the action of the ether on a particle is opposite to the direction the particle is accelerating. If now F is the vector sum of the forces acting on one particle then the above action principle may be stated as follows (page 17):

$$\Sigma(F + q) = 0.$$

The reviewer is not sure that he understands what the author means by kinetic reaction. On page 17 and also on page 150, he states that kinetic reaction is the action of the ether on a particle. And on page 150 he adds that "kinetic reactions are not aggressive. In this respect they are similar to resisting and fric-

tional forces, but the latter come into action with velocity, while the former come into play with acceleration." On page 152 he states that "both forces and kinetic reaction must be the same type of magnitude."

These statements, together with others, seem to indicate that the author considers kinetic reaction as something real and of the nature of a force. In fact it is a force, although the author on page 150 states that kinetic reaction can not be called a force because we have restricted the latter term to the action of one material body upon another. Call it what we will, to the reviewer it seems to be nothing more nor less than a backward pull of the ether on a body as the body moves through the ether with accelerated motion. In fact, the author seems to say that the inertia of a body is due to the force with which the ether is pulling back on a body when the body is being accelerated.

Assuming that the author's conception of kinetic reaction is here correctly given, the reviewer is inclined to believe that several questions will at once present themselves to the readers of his book.

Why is it that the ether acts on a body only when it is being accelerated and not when the body is moving with constant velocity?

If kinetic reaction is the action of the ether on a particle, and if it is the same kind of a quantity as force (is a force in fact), and if the resultant force F acting on a particle and the kinetic reaction q are always equal in magnitude but opposite in direction (both equal to ma in magnitude), why is the body not in equilibrium? The author recognizes this difficulty in a footnote (page 153) by stating in effect that we must not call kinetic reaction a force, for if we do then the vector sum of all the forces acting on a particle will always equal zero without this particle necessarily being in equilibrium, a state of affairs which is not consistent with the condition of equilibrium of a particle. Refusing to call kinetic reaction a force, however, in order to keep out of trouble simply dodges the question and does not answer it.

The reviewer does not wish to say that the author is wrong in his conception. All he wishes to say is that he entirely fails to appreciate the author's point of view.

There is considerable difference between the author's action principle and D'Alembert's principle. Let there be a number of forces acting on a particle, then the resultant force (an ideal force) equals ma, or $R = ma$. This ideal force may be called the effective force. D'Alembert's principle then says that a system of forces acting on a particle together with the reversed effective force will form a system of forces in equilibrium. It should be remembered that this reversed effective force is an ideal force and not a real force. Now in the author's action principle the kinetic reaction is a real force (or action as the author prefers to call it) and is due to the action of the ether on a particle.

The author's action principle (even if sound) involves a number of conceptions which must be understood in order to understand the principle itself, and it seems that such a principle ought to follow rather than precede an elementary treatment of mechanics.

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SPECIAL ARTICLES

EXPERIMENTAL ABLATION OF THE HYPOPHYSIS IN THE FROG EMBRYO

In the following preliminary paper the effect of the extirpation of the epithelial portion of the hypophysis upon the subsequent growth and development of tadpoles is summarized. The work was first attempted in 1914, *Diemyctylus torosus* being used, repeated in 1915 upon *Rana pipiens*, and again repeated in 1916 upon *Rana boylei*. In this paper the results obtained with *R. boylei* are reported.

The operation was most successfully carried out upon approximately 3 mm. larvæ, at which time the tail-bud is forming and the stomadeum can be detected. At that stage the epithelial hypophysial invagination can be accurately determined from the pit that it forms, or from its location between the protuberance of the forebrain and the stomadeum, and can be removed without injury to the adjacent brain.

This epithelial ingrowth was removed with some neighboring epithelium. The wound healed within three hours, less than 1 per cent. of the larvæ disintegrating after the operation. About 200 larvæ of the 3 mm. stage were operated upon, the hypophysis being successfully removed in over 60 per cent. of the cases. Approximately 30 per cent. of those animals in which the gland was extirpated did not give reliable results in the rate of growth as the mouth was wholly or partially removed thus interfering with feeding. For checks, unoperated specimens and those in which the ablation of the gland was unsuccessfully attempted were available. The operated animals and checks were kept in boiled water for five days and then transferred to a frog tank where they were in an essentially normal environment.

The hypophysis-free animals grew more slowly than the normal controls. No hypophysectomized animals reached the size of the largest checks and the averages of the two show a noticeable difference. On June 6 the operated but not hypophysectomized animals had an average length of 40–43 mm., the hypophysis-free animals averaging 33–35 mm. A ratio such as this prevailed throughout their growth. The ratio of body to tail length is the same in the two classes, the difference in size being uniform for all parts of the animal.

Differences in color began to be noticeable at an early stage. From then on the contrast in pigmentation between the hypophysectomized animals and the checks was striking. Those animals without a hypophysis had a slightly darkened silvery appearance of an almost uniform character; however, the dorsal side was more pigmented than the ventral. These are referred to as albinos. The checks were a brown-black color often showing a mottling. This color difference was more noticeable over the body than on the tail, but was evident in both regions and was the most striking feature up to the time when the hind legs began to appear in the checks. Sections show that in the albinos the epidermis is pigment-free while that of the checks is filled with it. The subcutaneous pigment is present in the albino in as great a quantity if not greater than in the normal animal. The retinal pigment appears to be the same in both.

The hind leg buds appear, normally, when the tadpole has reached a length of 25–27 mm. In the albino the hind limb buds appear but slightly later than in the checks or when they are from 26–28 mm. in length. From this stage on, however, the hind limbs in the hypophysectomized animals grow but little if at all, although their total length increases at a rate but slightly under the normal one. For instance in 28 mm. checks the hind legs average 1.0 mm.; in 30 mm. checks 2.0 mm.; in 38 mm. checks 4.0 mm. In the albinos of each of the above sizes and ages the hind legs were 0.1 mm. long. The above is in accord with Adler ('14),[1] who found that the removal of the hypophysis in a 20 mm. stage inhibited the growth of the hind legs.

Sections of the albino and normal animals show striking contrasts in the organs. Of the specimens yet sectioned none described above as albino or hypophysectomized have had a trace of the anterior lobe of the hypophysis present. Thus it is certain that the entoderm has not the intrinsic power to form a hypophysis, but that if it enters into the formation of the gland at all it must be considered as a tissue inclusion which may become changed through its adaptability into glandular parenchyma, a conclusion previously drawn by the writer Smith ('14).[2] Comparison with the checks shows that the infundibulum undergoes structural modifications, although the saccus vasculosus, as far as determined, appears to be normal. In the checks that region of the diencephalon which rests against the pars glandularis is of considerable thickness, having in addition to the ependyma a rudimentary pars nervosa. Caudad to this the wall is formed almost entirely of ependyma. In the hypophysectomized animals the pars nervosa

1 Adler, L., "Metamorphosestudien an Betrachierlarven. I. Extirpation endokriner Drüsen. *A.* Extirpation der Hypophyse," *Arch. f. Entwickelungsmech. d. Organ.*, Bd. 39, 1914.

2 Smith, P. E., "The Development of the Hypophysis of *Amia calva*," *Anat. Rec.*, Vol. 8, 1914.

is reduced throughout most of its extent to an ependymal layer. Small localized thickenings may occur but nothing corresponding to the normal animal.

The difference in size and structure between the thyroid of an albino and that of a check is very marked. The thyroid of a normal 38 mm. tadpole with 4.0 mm. hind legs is approximately three times the size of a 37 mm. albino with 0.1 mm. hind legs. The compactness and character of the parenchyma show an even more striking contrast. A sagittal section through the thyroid of a 38 mm. check shows on an average 15–18 vesicles, many of which are largely distended with colloid, the parenchyma of the whole gland being compacted together, as compared with that through the thyroid of a hypophysectomized 37 mm. specimen which shows 4–5 atrophied vesicles containing but a slight amount, or no colloid, and with large spaces between the vesicles. The cells making up the vesicles of the former are cuboidal and protoplasmic-rich, in the latter little but nuclei remain. The results obtained from the experimental feeding of thyroid by Gudernatsch and others makes it highly probable that the non-development of the hind legs in the albinos is due immediately to the atrophy of the thyroid and not to the direct action of the hypophysis, a suggestion which Adler's work upon the tadpole also supports.

An examination of the gonads shows significant size differences between the normal and albino specimens. In the hypophysectomized animal the development of the sex glands is apparently much retarded and the size correspondingly reduced.

The author in a later and more complete account will describe any changes which may be found in the other endocrine glands and treat of the progressiveness of the changes noted.

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EFFECT OF GRINDING SOIL ON THE NUMBER OF MICROORGANISMS

In connection with a study of the bacterial content of soil, it was found that pulverizing soil in a ball mill seriously affected the number of bacteria. This treatment not only reduced greatly the bacteria, but also that of many other microorganisms. In many cases the soil was partially air dry and contained clumps which were not easily broken by shaking in a water suspension. Because of the mass of soil particles, it was thought that perhaps grinding would result in a higher count. From the results below, it will be seen that such was not the case. Instead of a gain, there was a loss in number of organisms which was more marked the longer the soil was ground.

The test was made as follows: Fresh or partially air-dried soil, containing not more than 10 per cent. moisture, was placed in a ball mill partly filled with large pebbles. The mill was geared so that the porcelain jar revolved at the rate of 70 revolutions per minute.

TABLE I

A COMPARISON OF THE NUMBER OF BACTERIA IN GROUND AND UNGROUND SOIL

Test No.	Date	Soil	Bacteria in One Gram of Dry Soil		
			Unground	Ground	Time of Grinding, Hours
1	April 4	Miami silt loam	4,225,000	3,439,000	1
2	April 5	Red clay	626,000	570,000	1
3	April 6	Fine sand	216,000	198,000	1
4	April 11	Black silt clay loam	3,300,000	2,200,000	1
5	April 12	Colby silt loam	1,200,000	1,800,000	1
6	April 13	Carrington silt loam	2,000,000	400,000	1
7	April 14	Sandy loam	1,200,000	300,000	1
8	April 18	Medium sand	362,000	186,000	1
9	April 19	Plainfield loam	264,000	174,000	1
10	April 20	Muck	2,064,000	1,746,000	1
11	April 26	Miami silt loam	44,602,000	10,540	8
12	May 3	Garden soil	3,194,000	5,610	8
13	May 4	Garden soil	3,194,000	75	24

The following results, shown in Table I., illustrate the difference in the number of bacteria in the ground and the unground soil, as well as the effect of time of grinding on the number of bacteria. Grinding greatly reduced the number of bacteria except in one case, No.

5 Colby silt loam. Apparently the greatest injury caused by grinding for one hour is noted in the case of sandy soils.

When the soils were ground for 8 or 24 hours, there was an enormous decrease in the bacterial flora. This is readily noted from the figures of the last three soils given in Table I. After 24 hours of grinding the soil was rendered almost free of bacteria.

It is of interest in this connection to note the effect of long grinding on other soil organisms, *e. g.*, soil protozoa. Dilution counts on various culture solutions adapted to protozoa showed that the unground soils contained protozoa in dilutions greater than 1 to 10,000, while in many cases the ground soil failed to show any growth of protozoa. The garden soil, No. 12, contained protozoa in the first dilution, one gram in 10 c.c. of the medium. When ground for 24 hours this same soil did not show the presence of protozoa.

From the results, it seems fair to conclude that grinding soil in a ball mill injures the soil microorganisms. If this process is continued for several hours, the soil will be partially sterilized. Although no definite study has been made, it is most probable that the larger forms of plant life as fungi, yeasts and algæ suffer the same fate as the protozoa and bacteria.

E. B. FRED

UNIVERSITY OF WISCONSIN

AN ACOUSTIC DEMONSTRATION BEARING ON THE PULSE THEORY OF RADIATION

SOME years ago I made the acquaintance of the "pulse theory" of radiation. As I understood it then, the periodicity of any monochromatic light as observed by means of a spectral system was a function of the instrument of dispersion. If so, how various sources could give different spectra when their radiation was dispersed by the identical instrument was to me an unanswered question. It was unthinkable that there should not be some characteristic difference between the pulses, or their manner of succession, in the two cases.

The demonstration which I am about to describe developed as the result of a more recent informal discussion of the subject in this laboratory. It occurred to me that the acoustic analogy of such a theory should have as its consequence this fact: that an irregular series of impacts would cause wave disturbances in the air such that a resonator of any period, within certain limits, should respond.

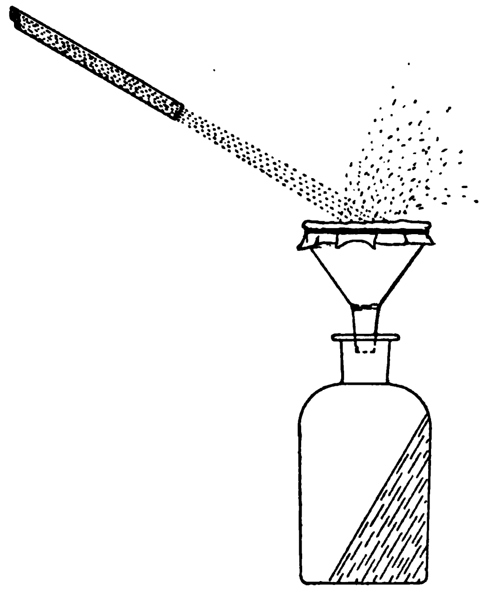

FIG. 1.

Such a series of impacts was furnished by a stream of sand-particles falling against an inclined paper surface, and the resonator was the classic glass bottle, which was made to respond to different periods by introducing different amounts of water.

Essentially the experimental set-up (which was about twenty minutes in construction) consists of a vertical glass tube of 7 mm. bore, constricted to about 4 mm. at a point near its top and some 42 cm. from its lower end; of a funnel, whose expanded end is covered with a rather loose diaphragm of thin tracing paper; and the resonator described. The sand was allowed to flow through the constriction in the tube, and the stream subsequent to this was kept from spreading too much by the portion of the tube below, falling freely a distance of 12 cm. from the lower extremity of the latter before striking the diaphragm (Fig. 1). The sand was what is known to the drug trade as

"fine silver sand," from which the smaller particles, to the extent of about one third of the mass, had been sifted out for another purpose. There is to my knowledge nothing critical about these specifications. They are simply the result of guess and circumstance, with the result about to be stated.

Several resonators were tried until one was found that worked properly in the position shown in the figure. Along with the general hiss and roar of the impact of the stream a faint, fluttering musical tone could then be distinctly heard when the ear was held close to the mouth of the bottle. By repeating the experiment with various amounts of water in the bottle tones of various pitches could be obtained, in every case sensibly identical with the tone obtained by blowing across the mouth of the bottle.

It would seem in advance that out of a helter-skelter series of impacts a group could be selected having, within certain limits, any given period with a sufficient degree of accuracy to set a resonator into action. Naturally such a state of things could not continue indefinitely. The individuals of the group could be expected to get out of step, stop the resonance by interference and set it going again in another phase. Hence the fluttering quality of the note, due apparently to the separate wave-trains so set up.

If the regular periodicity is a function of the analyzer, how may two pulse-series as supposed in the case of black-body radiation at two different temperatures give rise to characteristically different spectra? The answer to this question seems to me now quite natural. If we consider the effect, in this experiment, of varying the size of the constriction which limits the outflow of sand, it seems probable that increasing the outflow, by increasing the average number of impacts per unit time, would cause the resonator to give relatively greater response (as to amplitude or energy) at higher frequencies and *vice versa*. Another condition bearing on the "spectral distribution" of energy in this case would seem to be the relative numerousness of the different-sized particles composing the sand; other conditions being equal, the smaller ones presumably tending on the whole to give rise to high, the larger to low frequencies. This is merely speculation, as the careful experimentation necessary to show such changes has not been carried out.

The experiment as described here is scarcely demonstrable to more than one person at a time. It has certainly yielded large educational returns, to me personally at least, considering the insignificant outlay of time and material. I am especially interested in knowing whether it is essentially new or whether it has been proposed or used before.

P. W. Cobb

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A PRIMARY CIRCUIT KEY FOR QUANTITATIVE INDUCTION WORK

Physiological investigation requiring either the calibration of an inductorium or the use of such calibrated inductorium necessitates a

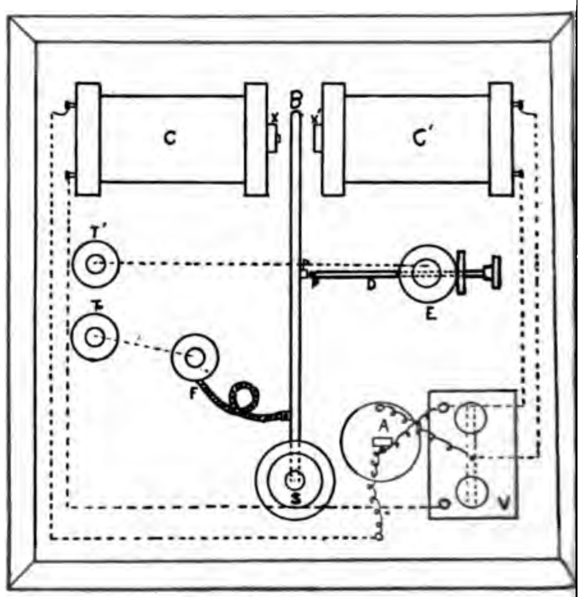

Fig. 1.

"make" and "break" key in the primary circuit which possesses certain qualities. Each

"make" and each "break" must occur with a constant velocity. The contact must be made and broken suddenly and firmly and there must be no vibration at the contact points.

Martin's key[1] has proved to answer these qualities but is not so compact as the key here described. Erlanger's key[2] designed to be used as a "knock over" key is not suitable for use except with a pendulum.

Such a large number of keys have been described that one hesitates to add another. It seems, however, that the simplicity of this principle and the ease with which this key may be used merits description.

In this key the well-known principle of induced magnetism is employed. The current for the coils (C and C') is obtained from a dry cell battery (A) so connected through an ordinary push-botton key (V) that when one button is down the current passes through one coil (C); when the other button is down the current passes through the other coil (C'). The coils contain soft iron cores (x and x'). One iron core (x) has a brass pin projecting from its center which prevents the steel band

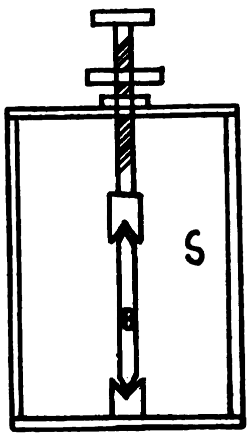

Fig. 2.

(B) from touching the core, thus eliminating any possibility of a "dead center" in the swing of the steel band. The contact points prevent the steel band from touching the other core. The steel band swings in an adjustable brass socket (S), the details of which are shown in Fig. 2. From the steel band a light spring wire (W) leads to a post (F) thus permitting free swing. For contact points, platinum iridium is used (P and P'). The one (P) is soldered onto the steel band and has a flat contact surface. The other (P') is soldered onto an adjustable brass pin (D) and has a convex contact surface. T and T' are the terminal binding posts from which connections are led to the induction coil. The whole is mounted on black fiber ⅜″ thick, the connecting wires being imbedded on the under side.

The key has not been tested out with the string galvanometer, but has been used in making calibrations and found to give satisfactory results.

R. E. Lee Gunning
Northwestern University
Medical School

[1] Martin, *Am. Jour. Phys.*, XXIX., 1910, 181.

[2] Erlanger and Gerrey, *Am. Jour. Phys.*, XXXV., 1914, 384.

THE AMERICAN CHEMICAL SOCIETY

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The Synthesis of p-Cymene Monocarboxylic Acids and of certain of their Derivatives: M. T. Bogert and J. R. Tuttle.

The authors have prepared the two possible ring isomers, cymene 2-carboxylic acid and cymene 3-carboxylic acid, from the corresponding bromo derivatives by the Barbier-Grignard reaction, using CO_2 under pressure, and have studied these acids and the following derivatives thereof: Na, K, Ba, Ca, Cu and Ag salts, methyl and ethyl esters, acid chlorides, amides, anilides, hippuric ester and acid compounds, hydrazides, furo- and thio-diazoles. Small amounts of the 2-acid have been obtained heretofore by other investigators and a few salts have been recorded, but we believe that this is the first time that the acid has been prepared in sufficient amount for more extended study. The isomeric 3-acid appears to be entirely new.

Benzoylene Urea and Some of its Nitro Derivatives: M. T. Bogert and G. Scatchard.

The preparation of benzoylene urea from anthranilic acid, through o-ureidobenzoic acid, has been improved. The nitro derivatives were prepared either from the corresponding nitro anthranilic acids or by direct nitration of benzoylene urea itself. These nitro benzoylene ureas are struc-

turally related to the nitro phenols, and certain of them have been found to be very sensitive indicators for the determination of hydrogen ion concentrations.

A New Group of Azo Dyestuffs: M. T. BOGERT.

It has been shown by various investigators, including the author, that azo dyestuffs may be prepared from quinazolines carrying a primary Bz-amino group, by diazotizing this amino group and coupling the resulting diazo bodies with any of the well-known couplers. It has now been found that quinazolines themselves may function as couplers and, by combination with various diazotized or tetrazotized bases, a new series of azo dyestuffs has been obtained.

Methylene Disalicylic Acid and Derivatives: ROBERT A. HALL.

The Addition Compounds of Phenols with Organic Acids: JAMES KENDALL.

Derivatives of l-Isocamphoric Acid—An Unusual Formation of a Methyl Ether of a Hydroxy Acid: WILLIAM A. NOYES AND GLENN S. SKINNER.

The method employed in the preparation of l-isocamphoric acid was that outlined by Noyes and Knight.[6] The methyl ester of isoaminocamphononic acid was prepared according to the procedure of Noyes and Littleton[7] with slight modifications.

The above ester was decomposed with nitrous acid and the following compounds have been found: (1) The methyl esters of two unsaturated acids, (2) the methyl ester of a hydroxy acid, and (3) the methyl ether of a hydroxy acid. Difficulties were encountered in the purification of the products. However, it has been shown without much doubt that one of the unsaturated acids is lauronolic acid. The physical constants of the hydroxy acid obtained by saponifying the ester correspond in the main to those of cis-camphonolic acid. The keto acid obtained by oxidation of this acid with chromic acid shows a like resemblance to camphononic acid.

The formation of the ether acid under the conditions of the experiment is, so far as we are aware, unparalleled. Its identity has been established by analysis and by the determination of the methoxy group according to the method of Zeisel. Its configuration has not been determined. The study of these compounds is being continued.

Researches on Pyrimidine-Nucleotides. New Developments: TREAT B. JOHNSON.

[6] *J. Am. Ch. Soc.*, 32, 1669.

[7] *Ibid.*, 35, 75.

The Action of Ferric Chloride and other Ferric Compounds upon Cellulose: LOUIS KAHLENBERG.

It has long been known that ordinary solutions of ferric chloride and other ferric salts have some solvent action upon cellulose. That action has hitherto been found to be but slight. However, a very concentrated solution of ferric chloride, such as is obtained by melting the usual commercial hexahydrate, dissolves cellulose with great ease. In fact, it is the best solvent for cellulose thus far discovered. The action begins at the melting point of the hydrate and proceeds very well at 50° centigrade. On heating to somewhat higher temperatures the action is very greatly accelerated. At the temperature of the water-bath it is a simple matter to dissolve 5 per cent. of cellulose in the concentrated solution resulting from the melting of the hexahydrate. More cellulose will be taken up until the whole mass becomes an exceedingly stiff syrup. On allowing the material to solidify it may be pulverized, and it will be found that it has to a very large extent lost its hygroscopic properties, which would indicate that a combination between the ferric salt and the cellulose has taken place. Attempts to isolate such a combination have been made and are still in progress.

When the solution of the cellulose in the concentrated ferric chloride solution is poured into water there separates out a precipitate of hydrated cellulose, which fact has been determined by careful analysis. Only a portion of the cellulose, however, is thus precipitated. The remainder stays in solution, having been converted into glucose. By heating the 5 per cent. solution of cellulose in the strong ferric chloride solution for two to three hours on the water-bath, all of the cellulose is converted into glucose. The ferric chloride may best be removed from such solution by diluting, treating with an excess of freshly precipitated basic lead carbonate, warming and filtering. Final traces of iron and lead are removed from the filtrate by means of ammonium sulphide. The filtrate then contains the glucose and some ammonium salts, but the latter do not interfere seriously with the characterization of the glucose by means of the test with phenyl hydrazine. Excellent crystals of glucosazone of characteristic melting point may be thus obtained from the solution.

Very concentrated ferric bromide and ferric sulphate solutions act similarly, but they are by no means equal to the ferric chloride in their solvent action. Not only may simple cellulose, like cotton and filter paper, be dissolved in the very

concentrated ferric chloride solution, but also compound celluloses, like woody fibers of all kinds, are thus disintegrated.

The entire subject is being pursued further, particularly as applied to the study of the compound celluloses and the various products that are associated with them in the various woods and woody fibers of different plants.

Similarly, concentrated solutions of the chlorides of other metals, like those of copper, cobalt, nickel, aluminum, calcium, magnesium, etc., have also been tested as to their solvent action upon cellulose. While these have some action upon cellulose, the action is quite slight as compared with that of ferric chloride. The action of ferric chloride upon cellulose, therefore, is a highly specific and unique one.

This entire subject is being studied further, especially as to its possible practical applications in isolating and utilizing various plant products.

DIVISION OF INDUSTRIAL CHEMISTS AND CHEMICAL ENGINEERS

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The Determination of Ash in Coals with a High Percentage of Calcium Carbonate: S. W. PARR.

The Mechanical Sampling of Illinois Coal: S. W. PARR.

A New Form of Adiabatic Calorimeter: S. W. PARR.

Report on Last Year's Progress of the Industrial Fellowship System of the Mellon Institute: R. F. BACON.

An Investigation of Composition Flooring: R. F. BACON AND R. R. SHIVELY.

A Contribution to the Chemistry of Laundering: H. G. ELLEDGE.

On the Use of Certain Yeast Nutriments in Bread Making: H. A. KOHMAN.

On Hydrated Lime: J. F. MACKEY.

On the Prevention of Glass Pot Corrosion: S. R. SCHOLES.

On the Behavior of Manganese in Glass: S. R. SCHOLES AND E. W. TILLOTSON.

Further Experiments on Volatilization of Platinum: G. K. BURGESS AND R. G. WALTENBERG.

This paper is a continuation of previous work on the loss in weight on heating of platinum laboratory ware. It is shown that all grades of platinum contain at least traces of iron, that there is no appreciable loss in weight of crucibles heated to 900° C., but that above this temperature the loss increases rapidly with temperature, is greatest for platinum containing iridium and least for platinum alloyed with rhodium.

The Isomeric Lactones, Caryophyllin and Urson: FRANCIS D. DODGE.

Caryophyllin $(C_{10}H_{16}O)_n$, constituent of clove buds, was thought to be an alcohol, $C_{40}H_{60}(OH)_4$, but the present work indicates that it is more probably an oxy-lactone, $C_{30}H_{48}O_3$. Salts, two mono-acetyl and a diacetyl derivatives have been prepared. Oxidation with nitric acid gives caryophyllic acid, $C_{30}H_{48}O_6$; and acetylation of this acid gave an acetyl derivative, m. 210°, probably from an oxy-di-lactone derived from caryophyllic acid by the loss of one molecule of CO_2 and of H_2O.

Urson, a constituent of bear-berry leaves (*Uva Ursi*), $C_{30}H_{48}O_3$, is probably an isomer of caryophyllin.

Both lactones give the color-reaction of Liebermann for the cholesterol series.

Tautomeric Equilibrium Constants and Chemical Structure. A Measure of Valence in Terms of Energy: C. G. DERICK.

Preparation and Characterization of Trimethylene Oxide: D. W. BISSEL AND C. G. DERICK.

Trimethylene oxide was successfully prepared by two methods. The first used was by the action of trimethylene chlorhydrine on fused potassium hydroxide at 140°, yield 6–8 per cent. The other method was by the action of the acetate of trimethylene chlorhydrine upon fused postassium hydroxide at 100–110°, yield 22 per cent. The oxide is purified by fractional distillation after removing unsaturated products by bromination. Its structure follows from the fact that it yields hexanol-1 with propyl magnesium bromide; and trimethylene chloride with phosphorus pentachloride. Trimethylene oxide is a colorless, mobile liquid; miscible with water and having a pleasing odor. B. P. 47.8° (corr.); $D_{4°}^{25°}$ 0.893; $(N)^{25°}$ 1.389 by Abbé instrument with ordinary light.

The Action of Metallic Oxides on Trimethylene Halides and of Heat upon $ClCH_2CH_2CH_2$-O-Mg-I: E. H. VOLLWEILER AND C. G. DERICK.

Lead oxide acts on trimethylene bromide at 200°, giving a substance boiling at 50–60° which consists mainly of unsaturated compounds. The yield was poor. A polymer of trimethylene oxide, boiling at 180° under 50 mm., is obtained. Its structure follows from the fact that it gives hexanol-1 with propyl magnesium bromide.

Mercuric and silver oxide react similarly, yielding no appreciable quantities of monomolecular trimethylene oxide. Trimethylene iodide can not

be used as it decomposes and the chloride reacts too slowly.

$Cl\text{-}CH_2CH_2CH_2\text{-}O\text{-}Mg\text{-}I$ prepared by the Grignard reaction decomposes at 270°, giving mainly trimethylene iodide and a small amount of product boiling at 70–100° which is partly ethyl iodide and partly some unidentified mixture of iodine compounds.

The Behavior of β-Phenoxy Ethyl Bromide in Wurtz-Fittig Synthesis: ST. ELMO BRADY.

The type of ether, $C_6H_5\text{-}O\text{-}CH_2CH_2Br$, was prepared from sodium phenolate and ethylene bromide and the reaction so regulated as to obtain a maximum yield of the bromethylphenyl ether instead of the diphenoxy ether which under certain conditions has an equal chance for formation with the bromethylphenyl ether. The regular Wurtz-Fittig synthesis was carried out with the single modification of varying the amount of sodium used. The products were ethylene gas, sodium phenylate, and α, δ-diphenoxybutane in 10 per cent., 20 per cent. and 30 per cent. yields respectively.

The interesting fact observed in this synthesis was the unvarying yield of α, δ-diphenoxybutane with increasing amounts of the reacting materials and an increase in the yield of ethylene gas under the same conditions. The yield of ethylene gas is directly proportional to the amount of sodium used.

Preparation and Characterization of ε-Acetylcaproic Acid: ST. ELMO BRADY AND C. G. DERICK.

Trimethylene bromide and acetoacetic ester were condensed, molecular proportions of the reacting substances being used. The resulting condensation product was hydrolyzed with 20 per cent. hydrochloric acid and the nonhydrolyzable matter separated. The aqueous portion is treated with solid sodium carbonate and the separating product removed and purified. This is γ-acetylbutyl alcohol. The alcohol is brominated and the bromide condensed with malonic ester. The 1, 1 dicarboxethyl heptanone-6, after purification, is hydrolyzed with 20 per cent. hydrochloric acid and the resulting dicarboxylic acid heated to 170°. By the loss of carbon dioxide the ε-acetylcaproic acid is formed. The acid is easily soluble in alcohol, ether and water and is somewhat hygroscopic. It melts at 28° and boils constant at 145° under 1 mm. pressure. The ionization constant is 1.638 .0005 $\times 10^{-5}$.

Preparation and Characterization of δ-Acetylvalerianic Acid: R. W. HESS AND C. G. DERICK.

Trimethylene glycol was converted into the bromide by refluxing with aqueous HBr. By using the proper proportions the yield was increased from 50 per cent. to 80 per cent. γ-Brombutyronitrile was made from the trimethylene bromide and KCN. When a mixture of water and alcohol was used as a solvent the yield was 20–25 per cent., but with absolute methyl alcohol it was 40–50 per cent. The action of γ-brombutyronitrile on sodium acetoacetic ester gave two new products, the one desired, δ-cyano-α-acetylvaleric ethyl ester and another 1, 7, -dicyano-4-aceto-4-carboxethyl heptane. The latter boils at 200° under 5 mm. pressure; melts at 73.5° and is insoluble in most organic solvents. An excess of acetoacetic ester prevents the formation of this substance. The former distills at 154° under 2 mm. pressure and hydrolyzes to δ-acetylvalerianic acid with constant boiling HCl. B. p. 181° under 25 mm. pressure; m. p. 36.5°; ionization constant 1.93 $\times 10^{-5}$.

A Study of the Isomeric Aminoethylbenzenes and Certain of their Derivatives: O. S. KEENER, O. KAMM AND C. G. DERICK.

Syntheses in the Naphthalene Series: OLIVER KAMM AND H. B. MCCLUGAGE.

A Study of the Equilibrium in the Friedel and Craft Reaction: OLIVER KAMM AND S. D. KIRKPATRICK.

On the Reactions of the Formamidines. V. On some Pyrazolone Derivatives: F. B. DAINS, H. R. O'BRIEN AND C. L. JOHNSON.

Contributions to our Knowledge of Dichlorether. Part II.: G. B. FRANKFORTER AND S. J. REICHERT.

The Action of Aluminum Chloride on the Alcohols and Carbohydrates Alone and in the Presence of Other Organic Compounds: G. B. FRANKFORTER AND V. KOKATNUR.

A Catalytic Decomposition of Some Phenol Salts: W. H. HUNTER.

Some Work on the Reimer-Tiemann Reaction: W. H. HUNTER.

Notes on the Use of the Multiple Unit Electric Furnace and of a Modified Carbon Dioxide Generator in the Dumas Method for the Determination of Nitrogen: HARRY L. FISHER.

The furnace has excellent temperature control with all ranges, the units are well insulated, and it has a nickel trough which is permanent and does not stick to melted glass. The combustion tube can be inspected at any time.

The generator is arranged for either pressure or vacuum work and can be constructed of varying capacity and in a compact form. It consists of two round-bottomed flasks, the upper being in-

verted and connected with the lower one with a T-tube, which allows equalization of pressure in both flasks, and a 3-way stopcock. By means of the latter sulfuric acid may be dropped upon sodium bicarbonate in water or the acid in the upper chamber replenished or removed.

The Relations in Composition of Petroleum, Coal and Natural Asphalts: C. F. Mabery.

I have distilled Palmyra, C., coal in vacuo to compare the products with the constituents of Mahone petroleum which is in the same section. The distillates were composed of an oil heavier than water which was composed to a considerable extent of color substances which appeared during purification of the hydrocarbons in various shades of red, green, blue and violet. From the lighter oil was separated a number of hydrocarbons of the series C_nH_{2n}, C_nH_{2n-2}, C_nH_{2n-4}, resembling the hydrocarbons separated from Mahone petroleum, three years ago. A considerable proportion of solid hydrocarbons were separated, including some of the higher paraffines. Acetic aldehyde appeared in the lower distillates as it has been recognized in Mahone petroleum. I have also distilled Gilsonite in vacuo and obtained 56 per cent. of a thin oil from which a series of hydrocarbons similar to those in petroleum. Three classes of products were separated; the last mentioned, that evolve HBr copiously with bromine, forming a substitution lighter than water, a second, closely resembling hydrocarbons of a different character, that I mentioned 25 years ago as separated from acid sludge, and then alluded to as resembling the terpenes, giving with bromine hydrobromic acid and a product heavier than water, and a third class, composed of nitrogen derivatives like those I described 15 years ago as from California petroleum and recently identified in other varieties, especially in larger amount from Russian (Baku) petroleum. These products are at present under examination.

The Occurrence of Esdragol in Rosin: Charles H. Herty and V. A. Coulter.

On the Phenolsulphonphthalein Dyes and the Quinonephenolate Theory of Indicators: E. C. White, H. A. Lubs and S. F. Acree.

On the Use of Viscose as a Dialysis Membrane: H. A. Lewis and S. F. Acree.

On the Tautomeric Reactions of the Silver and Mercury Salts of 1-Phenyl-4, 5-dihydro-5-oxy-3-triazolyl Methyl Sulphone with Alkyl Halides: E. H. Wight and S. F. Acree.

On the Reactions of Both the Ions and Molecules of Acids, Bases and Salts: The Inversion of Menthone by Sodium, Potassium and Lithium Ethylates: W. A. Gruse and S. F. Acree.

The Galactan of Larix occidentalis: R. W. Schorger and D. F. Smith.

Further Evidence for the Electronic Formula of Benzene and the Substitution Rule: H. S. Fry.

Reactions in Non-aqueous Solvents: Chromyl Chloride and Phosphorus Halides: H. S. Fry and J. L. Donnelly.

Electronic Tautomerism: The Existence of Electrometers in Dynamic Equilibrium: H. S. Fry.

Partial Hydrogenation of Cotton-seed Oil: Ben H. Nicolet.

The Reaction between Alcohols and Hydrochloric and Hydrobromic Acids: James F. Norris.

The Nitro Phenyl Ethers: Hilton Ira Jones and Alfred N. Cook.

The ortho and para nitro phenyl ethers have been studied and numerous errors corrected. Eighteen sulphonic acid salts have been prepared and seventy-two new phenyl ether dyes, several of which are of brilliant shade and have commercial possibilities. These are equally divided between the ortho and para ethers of the sulphonated and unsulphonated series. A new method has been devised for the preparation of potassium phenolate to all non-nitro phenols. The effects of the positions of the groups upon the properties of the compounds and colors of the dyes have been carefully studied and various interesting facts observed.

The Relations in Composition of Coal, Petroleum and the Natural Asphalts: C. F. Mabery.

In distilling Deerfield, O., coal in vacuo, and gilsonite, it is found that the distillates contain petroleum hydrocarbons of the series C_nH_{2n-2}, solid paraffines, the series C_nH_{2n-4}, and nitrogen compounds resembling those which have been separated from California, Russian and other petroleums. Intense colors appeared in some distillates. A series of terpenes appeared resembling those extracted by acid from petroleum. Naphthene acids were recognized. These products and also a new series of petroleum hydrocarbons, probably terpenes, separated twenty years ago in large quantity with the sulphur compounds, are under examination.

Esterification of Acids by Isomeric Mercaptans: J. W. Kimball and E. Emmet Reid.

It has long been known that alcohols of different structure show different velocities and limits of esterfication, these values being much lower for secondary than for primary alcohols. It has also

been shown that mercaptans are analogous to alcohols in esterfication. In the present work the rates and limits of esterification of benzoic acid by normal, iso-, and secondary butyl mercaptans have been measured at 200° and the same relations found to hold with the mercaptans as with the alcohols.

Esterification of Acids by Isomeric Mercaptans: J. H. SACHS AND E. EMMET REID.

Since with a given alcohol, isomeric acids show different esterification velocities, the present work was undertaken to find whether the same relations hold when isomeric acids are esterified by the analogous mercaptans. The three toluic acids have been heated with ethyl mercaptan at 200°. Esterification progresses most rapidly with the meta isomer and most slowly with the ortho. The limits are nearly the same, 14.4, 13.2 and 13.3 per cent. for ortho, meta and para, respectively.

Catalytic Preparation of Nitriles: G. D. VAN EPPS AND E. EMMET REID.

It is known that when the vapors of acetic acid and of alcohol are mixed and passed over certain metal oxides at high temperatures, water is split off and ethyl acetate is formed. It is now found that when the vapor of acetic acid and ammonia gas are passed over alumina at 500°, water is eliminated and acetonitrile is formed up to 85 per cent. of the theoretical.

$$CH_3COOH + NH_3 = CH_3CN + 2H_2O.$$

The Preparation of Nitriles: G. D. VAN EPPS AND E. EMMET REID.

Reid's method for the preparation of nitriles, which consisted in heating a mixture of the zinc salt of the organic acid and lead sulphocyanide, and which gave good results with aromatic acids, has been extended to aliphatic acids and good yields obtained. The preparation of acetonitrile was extensively studied, a large variety of modifications of the method being tried. Good yields have been obtained, but this method is rendered obsolete by the discovery of the catalytic method.

The Identification of Acids: E. EMMET REID.

p-Nitrobenzyl bromide has been found to be an excellent reagent for the identification of acids. One gram of this reagent is boiled an hour with an excess of the alkali salt of the acid in 15 c.c. of 63 per cent. alcohol. *E. g.*, $O_2N \cdot C_6H_4 \cdot CH_2Br + CH_3COOK = KBr + CH_3COO \cdot CH_2 \cdot C_6H_4 \cdot NO_2$.

The p-nitrobenzyl esters so formed crystallize well as a rule, have good melting points, and convenient solubilities. With the alkali salts of phenols, under the same circumstances, the same reagent forms ethers which are convenient for the identification of phenols.

Some Anomalies in the Solidification Points of Fats: B. H. NICOLET AND L. M. LIDDLE.

On the Nitration of Toluene: I. W. HUMPHREY.

The Hydrolysis of Chloropentanes as affected by High Pressures: Synthetic Fusel Oil: H. ESSEX AND B. T. BROOKS.

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Neutral lead propionate is formed almost quantitatively when lead carbonate is treated with hot, dilute propionic acid. It is an amorphous, white solid, very soluble in water, insoluble in ether. If the tetroxide be treated with dilute propionic acid, the black dioxide is thrown out on boiling the mixture, and neutral lead propionate is formed practically quantitatively. If litharge containing a considerable percentage of carbonate be used, neutral lead propionate, rather than either of the basic propionates which are reported, is formed. Analysis shows that lead carbonate will give the purest propionate, and the yields in this case are also the most satisfactory. Lead and hydrogen determinations, also the reaction with chlor di methyl ether whereby lead chloride is formed quantitatively, were used to identify the salts prepared.

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DIVISION OF FERTILIZER CHEMISTRY

J. E. Breckenridge, *Chairman*

F. B. Carpenter, *Secretary*

Plant Food Deficiencies of Coastal Plain and Piedmont Soils: C. B. WILLIAMS.

CHARLES L. PARSONS,
Secretary

(*To be concluded*)

SCIENCE

FRIDAY, SEPTEMBER 1, 1916

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MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

THE EVOLUTION OF HERBS

THE most ancient system of botanical classification which we know, first proposed by Aristotle and Theophrastus and even continued after the dawn of modern botany with the herbalists of the sixteenth century, divided all plants into three great and easily distinguishable groups, the trees, the shrubs and the herbs. As time went on, however, and as botanical knowledge grew more and more thorough, it became evident that any system of this sort, based simply on the habit of growth, not alone brought together many plants unrelated in almost every respect but separated others which clearly resembled one another in most of their characters. The old classification was therefore gradually abandoned and in its place grew up various systems in which an attempt was made to gather plants into more natural groups. Finally the theory of evolution, with its emphasis on actual genetic relationship as the basis of all sound classification, gave a great incentive to the building of hypothetical family trees and lines of descent in the vegetable kingdom. Almost all of these have been founded mainly on a comparative study of the various floral parts; and it is therefore with such structures that modern students of the morphology and taxonomy of plants have for the most part concerned themselves. The various types of growth habit, those most evident and striking of plant characters, so much emphasized by the earlier botanists, have consequently been largely neglected as being too variable and too dependant on a changing environment to be of much use in determining actual relationships.

But however valueless an inquiry which concerns these more conspicuous distinctions may be in tracing outlines of descent and determining the evolution of *flora*, it does provide us with important information as to the origin and development of plant forms, the evolution of *vegetation*. In many ways this knowledge is of more importance than the construction of family trees alone, for it is more often the growth habit of plants rather than their systematic position which is correlated with the climatic, geological and zoological factors in their environment. Indeed, to man himself the distinction between an herb and a tree is frequently of greater economic significance than that between two families of plants.

Investigations on this problem of the evolutionary history of growth forms among the higher plants has produced evidence from various sources that in comparatively recent geological time there has been a radical change in the character of much of the earth's vegetation, perhaps the most important one since the appearance of the angiosperms; a change produced by the origin and wide dispersal of those lowly but numerically abundant, quickly maturing and rapidly spreading plants, the herbs, in a vegetation which seems to have been previously composed almost entirely of trees and shrubs. Light has also been thrown on the factors which were responsible for the development of this new plant type and on the far-reaching changes which its introduction has caused in the history of plants, animals and man.

In any such problem of evolution as this we naturally turn first to a study of the fossil record. Of course the very earliest of land plants, if our present theories are correct, were delicate semi-aquatic species, probably resembling our modern liverworts, plants which from their essentially herbaceous structure failed entirely of preservation. As to the development of these lowly forms into the vigorous and land-loving vascular plants which are now so completely dominant we know almost nothing, either from the geological record or from the occurrence of intermediate types. The luxuriant vegetation of the latter part of the Paleozoic, which gave us our first fossil plants, was composed of various ancient types of ferns, lycopods, horse-tails, cycad-ferns and gymnospermous seed plants. It is significant that although nearly all of these were either trees or stout woody forms, their representatives which have been able to survive to the present time have with few exceptions been reduced to such an herbaceous stature as characterizes our ground pines, horse-tails, quillworts and ferns to-day. Among the angiosperms, which occur as fossils only since the lower Cretaceous, a similar change seems to have occurred for nearly every one of the early fossil members of this great group were apparently woody plants. Of course it must be borne in mind, as in all such cases, that the geological record may not present us with a fair sample of an ancient flora; for the leaves of woody species would in general be much more favorable for preservation than the more delicate ones of herbaceous plants. As far as it goes, however, the geological evidence tends to indicate that among vascular plants, at least during the period covered by the earlier fossil record, woody forms were the dominant type of vegetation.

The labors of the botanical taxonomists have also provided us with a valuable clue as to the history of growth habits, particularly among the angiosperms. This now dominant race is generally agreed to have descended either from cycad-like types or from forms related to the conifers. Both

of these groups are to-day (and seem always to have been) composed entirely of woody plants. Furthermore, although opinion is still divided as to which of the living angiosperms are the most ancient, it is generally agreed that this distinction belongs either to the naked-flowered, catkin-bearing types grouped together as the Amentiferæ, or to the complete but simple-flowered Ranales. The former are almost exclusively trees or shrubs to-day and the latter are predominantly so, making it probable that the angiosperms at their inception were woody in character. Moreover, in cases where a particular genus, family or order contains both woody plants and herbs and where it is possible, on evidence from other sources, to determine which members are primitive and which are more recent, it is found in practically every instance that the woody forms are more ancient in type than the herbaceous ones. This is well illustrated in the Leguminosæ. Here the two most primitive sub-families, the Mimosæ and Cæsalpineæ, are almost exclusively woody, practically all the herbaceous forms being included in the obviously less ancient Papilionatæ. Evidence derived from a study of plant descent therefore also indicates the greater antiquity of the woody type of vegetation.

This conclusion again receives confirmation from a study of the anatomical structure of woody plants and herbs, for in the latter the various elements of the wood—the vessels, rays and parenchyma—are often widely different from their primitive condition as we see it in admittedly ancient types of vascular tissue, and have evidently undergone much modification and specialization.

The distribution of these various growth types over the globe to-day is of expectional interest in providing us with evidence not only as to their relative antiquity but as to the factors which have caused the change from one type to the other. The most striking fact which such an investigation establishes is the overwhelming predominance (in number of species) of herbs in temperate regions and of woody plants in the warmer parts of the earth. In Table I. are shown the numbers and percentages of herbaceous species in the floras[1] of nineteen typical regions.

TABLE I

	Total Species	Herbaceous Species	Per Cent. Herbs
Ellesmereland	76	71	93
The Faroes	164	150	91
Switzerland	1,899	1,726	91
Iceland	221	200	90
Great Britain	927	821	89
Rocky Mountains	2,206	1,910	87
Russian Empire	14,704	12,588	86
Germany	1,117	947	85
Spain	4,481	3,554	79
Northern United States	2,662	2,089	78
Japan	3,257	1,861	57
Florida Keys	415	225	54
Tropical Africa	8,577	3,560	42
Hongkong	728	293	40
Ceylon	1,793	670	37
British West Indies	2,249	675	30
Java	3,188	867	27
Brazil	15,981	4,092	26
Lowlands of the Amazon Valley	2,209	265	12

It will be noted that in the tropics only about ten to forty per cent. of the species are herbaceous, but that as we go into cooler regions the proportion of such plants greatly increases until in arctic and alpine areas they constitute ninety per cent. or more of the flora. Of course these figures do not mean that the *vegetation* of temperate regions is mainly herbaceous. Forests, indeed, are well developed there, but they are composed of only a few hardy families of trees; whereas in the tropics almost every family has numerous woody representatives. The tropical floras analyzed included in almost all cases many plants

[1] In these analyses dicotyledonous plants alone are considered.

from cool upland or mountain regions, where herbs are commoner than in lowlands, and the herbaceous percentage is accordingly higher. In the lowland tropical forest, however, as is shown in the selected figures for the Amazon Valley only, herbaceous species are extremely few.

The most important limiting factor to the spread of tropical vegetation seems to be the occurrence, even for a very short time during the year, of temperatures near the freezing point. As to just what the climate was like under which the angiosperms first appeared we are not altogether certain, but freezing temperatures seem for the most part to have been quite absent. We may reasonably infer that conditions then favored an overwhelming development of trees and shrubs such as we see in winterless regions of the earth to-day.

An examination of those floras which are believed to be very ancient and to be composed of plant types which have elsewhere disappeared, is of especial interest for our problem. The organic life of certain isolated oceanic islands, in particular, is generally recognized as giving us a rough idea of the fauna and flora which existed over wider areas in ancient times; and the "endemic" animals and plants—those which are peculiar to the region and are found nowhere else, and which in such oceanic islands constitute a large proportion of the species—are regarded as still more ancient than the non-endemic element; for they must either have had a long evolutionary history in the region or must be remnants of older types which have elsewhere become extinct. Table II. shows the percentage of herbs among the non-endemic species (most recent element); the endemic species of non-endemic genera (intermediate element); and the species of the endemic genera (most ancient element) in certain of these insular floras.

TABLE II

	Recent Element, Per Cent. Herbs	Intermediate Element, Per Cent. Herbs	Ancient Element, Per Cent. Herbs
Hawaii (582 species)	76	21	9
Fiji (563 species)	26	2	0
Juan Fernandez (89 species)	94	27	0
St. Helena (41 species)	73	32	0
Socotra (517 species)	85	26	9
Mauritius and the Seychelles (587 species)	59	16	5

It is evident that the youngest element is predominantly herbaceous, the intermediate one less so, and the oldest almost entirely woody. In fact, the great majority of herbs in these insular floras apparently arrived such a short time ago that they have not yet developed into endemic types, but are still identical with species in other regions. This is the more noteworthy since herbs, because of the brevity of their life-cycles and their consequent multiplication of generations, tend to change more rapidly than woody plants. The vegetation of these ancient islands thus seems to have been, in times not very remote, even more devoid of herbs than it is at present. In such islands as Bermuda and the Azores, on the contrary, where from the almost complete absence of endemic species we have reason to believe that the flora is not ancient, the percentage of herbs is fully as high as in continental areas of similar climate.

The larger land masses of the south temperate zone—Australia, New Zealand, southern South America and South Africa —which have also been isolated in a greater or less extent from the continental areas of the northern hemisphere, resemble ancient oceanic islands to a certain degree in the composition of their vegetation. In Table III. are shown the percentages of herbs among the species of the non-endemic genera (recent) and among the endemic genera (ancient) in the floras of these regions.

TABLE III

	Recent Genera, % Herbs	Ancient Genera, % Herbs
Australia (5,711 species)	62	17
New Zealand (1,026 species)	81	20
Southern South America (1,587 species)	87	48
South Africa (7,984 species)	58	30

Here again, though not to as marked a degree as in insular floras, the more ancient element is predominantly woody and the more recent predominantly herbaceous.

It is noteworthy that there are many species of plants in the ancient insular floras which are identical or nearly identical with species on widely distant oceanic islands or on ancient continental areas, a fact which strengthens our belief that the vegetation of these regions is a remnant of one which was formerly much more widely spread.

If the herbaceous element in the vegetation of such isolated regions as we have described is entirely or in great part of recent arrival, we naturally look for its seat of origin to the extensive land areas of the north temperate zone where herbs to-day reach such high development, and where so many new types of animals and plants have had their birthplace. Even here there is evidence that the woody element in the vegetation was at one time much more diversified and prominent than at present, for very many genera and families of trees and shrubs are found here as fossils from the Cretaceous and Tertiary which are absent from the living floras. This is particularly true of Europe, where there are to-day so few species of woody plants.

These facts—that woody plants are more ancient than herbs as shown by evidence from fossils, from natural relationships and from anatomy; that herbs are now dominant and woody plants few in species in regions subject to low winter temperatures, and *vice versa;* that regions which have been isolated from the north temperate land mass possess few herbs in the ancient portion of their floras, and that the northern continents supported at no very ancient date a much more varied woody vegetation than at present—all suggest the conclusion that a large portion, at least, of our modern herbaceous vegetation originated in the north temperate zone in response to the progressive refrigeration of climate which we know to have taken place there during the Tertiary.

The great advantages conferred by the possession of an herbaceous habit of growth in a region subject to low winter temperatures are obvious, for such plants are able to complete their cycles and to mature seed in the warm summer months and can then survive the cold of winter in the form of resistant seeds or by hibernating underground. Only the hardier types can maintain permanent aerial stems under these conditions. The more delicate woody families have either been exterminated outright in temperate regions or have survived only by assuming an herbaceous habit and thus flourishing in that part of the year which is free from frost. As might be expected if low temperature has indeed been the determining factor in the development of herbs, most of those families which are well able to survive cold as trees or shrubs and which form the bulk of the woody vegetation of the north temperate zone—the willows, birches, oaks, beeches, walnuts, hickories, wax myrtles, elms, hollies, maples, heaths, buckthorns, lindens, planes, sumachs, cornels, and viburnums—are families which are almost entirely without herbaceous members. Being hardy, they have not been forced to adopt the herbaceous habit.

As to the details of this change in growth habit we can not of course be sure, but in those forms which it did not kill outright

the increasing cold probably effected a gradual reduction in size and an attendant shortening of the time necessary to reach maturity, until very dwarf forms were produced which were able to develop from seed to seed in a year or two, and which could be killed back to the ground every winter—in short, perennial herbs. The herbaceous vegetation in arctic and alpine regions to-day is still composed almost entirely of such plants. The annual herb seems to have developed from this primitive type under more favorable environments, where a plant growing from seed, and thus without a subterranean food reservoir to give it a rapid start, could become large enough in a single season to reproduce itself.

The northern vegetation thus developed proved extremely hardy and aggressive, and was able not only to overspread the great continental area of the north temperate zone but to invade as well the tropics and even the Antipodes. The presence of a large number of typically northern genera of plants in Australasia, southern South America and South Africa, often separated from their related forms by the whole width of the tropics, has long been recognized as one of the most fascinating problems of plant distribution. It is important to note that this invasion of northern plants (nearly 200 genera are known) which has been so successful in penetrating far southern regions and which displays so well the "wonderful aggressive and colonizing power of the Scandinavian flora" to which Wallace and others have called attention, has in reality been an invasion of *herbs,* for almost none of the northern trees and shrubs have participated in it.

Herbaceous plants have also been developed in the south temperate zone apparently in response to the refrigeration of climate there in the late Tertiary. Antarctic herbs were doubtless among the very last plants to leave the polar continent as the glaciers advanced. They are still almost all alpine or cold-loving perennials and have as yet failed to give rise to the aggressive lowland annual type.

Refrigeration of climate was doubtless not the only factor in the development of an herbaceous vegetation. A large body of such plants seem to have originated in arid regions, where they spring up rapidly and produce seed during a rainy season, thus bearing precisely the same relation to extremes of moisture that arctic or alpine herbs do to extremes of temperature. The assumption of a rapidly climbing habit, especially in the tropics, has also resulted in the development of an herbaceous type of stem in such families as the melons, milkweeds and passion-flowers.

But whatever the cause of their origin, herbs have proved themselves an exceedingly versatile and aggressive type of vegetation under almost all climatic conditions. The reasons for this dominance of the herb are not far to seek. It is able not only to thrive in cold and arid regions but, from the brevity of its life-cycle, can take advantage of temporarily favorable conditions of any sort. Its evident and great superiority over woody plants in rapidity of dispersal and ability to invade new areas quickly is due in large measure to the fact that its interval from seed to seed, instead of being many years, is only a few months. Every seed may itself become a center of dispersal in a season's time. The amount of seed produced, too, in proportion to the bulk of plant body which has to be developed is far greater among herbs than among woody forms. Owing to the rapid multiplication of their generations herbs are capable of more rapid evolutionary change than are trees or shrubs and hence are able to adjust themselves more rapidly to new conditions.

With these various advantages it is not surprising that the herbaceous habit to-day characterizes not only great numbers of the commonest and most dominant native plant species in all parts of the world but also that huge array of hardy and ubiquitous plants which we know as weeds.

This radical change in the growth habit of many plants from a woody to an herbaceous type which has taken place for the most part since the beginning of Tertiary time cannot have failed to exert an important influence on animal life. It may well be connected with the rapid evolution of mammals which we know to have occurred after the early Tertiary. To quote from Chamberlin and Salisbury:

> The earliest Eocene mammals were much more primitive and obscurely differentiated than even those of the middle Eocene, and this rapid backward convergence seems to point to some set of conditions which caused an exceptionally rapid development of the great class at this stage, whatever their previous history had been. The coming into a new domain of rich and varied conditions, whether by immigration or indigenous development, may be safely included among those conditions.

Is it not reasonable to suppose that the appearance of a great body of herbaceous vegetation just at this time was one of these conditions? This would affect directly the development of all herbivorous types and indirectly of many others. In the evolution of the tooth of the herbivora, indeed, we can trace the change from a sharply cusped type, suitable for chewing tough leaves and twigs, to the modern flat condition which is capable of dealing only with the softer herbaceous tissues.

The development of herbs was also apparently of some importance in the evolution of bird life, for the appearance of an immense new food supply produced by this terrestrial, seed-bearing vegetation, must certainly have led to the much greater abundance of such ground-loving types as the finches and others, and may well have been responsible for their origin. So closely are plants and insects related, too, that a radical change in the one can not have been without effect on the other.

Far more important, however, is the part which the herb has played in the development of human civilization. Primitive man seems to have been mainly arboreal in his habits, or at least primarily a forest dweller, and the wood, bark and fruit of trees and shrubs were of supreme importance to him as sources of shelter, fuel, implements, clothing and food. One of his first steps from this barbarism toward civilization was to enter the open and begin the practise of agriculture. Those plants which most commended themselves to the earliest tillers of the soil were probably not the slow-growing trees and shrubs but rather the herbs, since the rapidity with which they grow and reach maturity makes possible their culture even among such roving tribes as were our North American Indians. Only as man acquired a settled place of abode and a more permanent form of society could he begin the culture of woody plants in orchard and vineyard; and it is only in very recent times that agriculture has extended beyond these fruit-bearing trees and shrubs and, in the form of forestry, has begun to treat timber trees themselves as a crop to be cultivated.

The marked superiority of the herb in ease of agricultural manipulation, together with the wide variety of uses of root, stem, leaf and fruit, have given it an increasingly high place in man's favor. To be sure, trees and shrubs provide us with timber, fuel, paper, rubber, fruits, nuts, coffee, tea, cocoa, vineyard products, turpentine and many drugs and items of lesser consequence. Among herbaceous products, however, are found all the cereals and vegetables, together with sugar, tobacco, most

of the fibers, certain of the fruits, and very many other valuable commodities. In addition to all this, the animal industries, which are the sources of milk, meat, leather and wool, are dependent entirely upon herbs. The dominance of such plants in agriculture is shown by the fact that in the United States they contribute 96 per cent. of the value of the products of this fundamental industry. Without herbs, the feeding and clothing of our great populations to-day would be quite impossible, and though it is conceivable that with the advance of science civilized man might possibly dispense with woody plants, in the absence of herbs he would perforce revert almost to savagery again. Human society is essentially an herbaceous product.

Although a study of the evolution of growth-habits may not provide much information as to the natural relationships of the higher plants, as we remarked at the outset, it does nevertheless introduce us to a momentous chapter in the history of the vegetable kingdom, for these lowly forms have not only possessed the earth and determined the character of many types of animal life, but to their indispensable aid man himself really owes his career as a civilized being.

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CONTRIBUTIONS OF CHEMISTRY TO THE SCIENCE AND ART OF MEDICINE[1]

AT the last two meetings of this Society the general sessions have been devoted chiefly to symposia upon the contributions of the chemist to the varied phases of our American industrial development. Such emphasis is both timely and well merited. But I am impressed that this record of achievement should not be closed without some consideration of the contributions of chemistry to the science and useful art of medicine. The opportunity seems likewise propitious for some suggestions as to means by which future contributions in this direction may be increased in number and in value.

The *science* of medicine consists in the knowledge of the normal processes of the human body (physiology) and of the nature and causes of abnormal deviations (pathology). The *art* of medicine includes the prevention of such deviations (hygiene), their identification (diagnosis) and their correction or alleviation by therapeutic or surgical treatment. For its present state of development each of these branches owes much to the contributions of chemistry.

Since Lavoisier's demonstration of the identity of respiration with combustion the chemist has gone step by step with the physiologist in elucidating the normal operations of the first internal combustion engine. Chemical structure of inanimate carbohydrates, lipins and proteins sheds reflected light upon the reactions and structure of living protoplasm. Colloidal chemistry, catalysis and the laws of chemical dynamics furnish all that we know of those servants of the cells, the enzymes. A new constituent of the blood is recognized to-day and to-morrow we have a new theory of metabolism. Thermochemistry is the foundation of nutrition and dietetics. The occultism of biogenesis, growth and the internal secretions is giving way before the calorimeter and the differential equation. In a word, the whole datum of physiological chemistry is a contribution to physiology and hence to the science of medicine; that much of it yet lacks practical application is no discredit to the contributor.

So much yet remains to be done in the field of chemical pathology that we are sometimes inclined to disparage past achievements. But these are not inconsiderable. In edema, concretions, diabetes and other conditions of acidosis, pathological variations in metabolism in fever, and in numerous other directions substantial gains have been recorded. Uric acid

[1] Presented to the Division of Biological Chemistry of the American Chemical Society at the spring meeting at Champaign, Ill., April 17–21, 1916.

has been found not guilty of most of the offenses charged in the earlier indictments—and part of the responsibility for gout must be borne by as complete a chemical abstraction as tautomerism. But, by all odds, the greatest progress in the field of pathology is the widening recognition that in the future the important advances must be made by the chemical rather than by the histological route.

These contributions of chemistry to the science of medicine are for the most part distinctly modern. Far earlier were many of those to the *art*. Paracelsus gave chemistry a practical object as it emerged from the clouds of alchemy when he declared that "the object of chemistry is not to make gold, but to prepare medicines." In England, to-day, the drug store is the "Chemist's Shop," and those are not lacking in this country to whom the term chemist has a similar significance. Both are the spontaneous acknowledgment of the services of the chemist in supplying these tools of the physician. For if Paracelsus, Franciscus Sylvius and their followers of the iatrochemical school failed in their effort to develop chemistry simply as an adjunct to medicine they planted the seed which through many generations have brought forth Liebig's chloral, Ehrlich's salvarsan and the host of other synthetics which make up most of the materia medica of to-day.

The development in synthetic drugs which has followed the recognition of a connection between chemical structure and pharmacological action is a fascinating story; less, possibly, on account of actual results than because of the tantalizing probabilities. But with the establishment of the definite effects of at least some configurations and a measurement of the mutual influence of different radicals have come practical results. Guided by this information, old remedies have been improved by blocking the groups responsible for secondary effects or entirely replaced by better ones constructed to specifications. At the same time experimental pharmacology has been stimulated with the result that the modern physician has at command, for producing almost any desired effect, a variety of drugs of great reliability.

But internal therapy does not exhaust the resources of treatment and if synthetic chemistry has done much for the former it has done still more for surgery and the surgical specialties. Anesthesia and asepsis are the pillars of these structures—and the stones of the pillars are the synthetics ether, chloroform, iodoform.

Strangely enough, diagnosis is the last branch of medicine to which applied chemistry has brought substantial benefit. To be sure we have had for many years an attempt at diagnosis by means of qualitative tests.[2] The urinalysis consisting only of qualitative tests for sugar and albumin is worth just as much as the feel-your-pulse, see-your-tongue, give-you-calomel variety of clinical diagnosis and treatment—just as much and no more. The essentials of progress may be a slow and steady growth, but the results usually appear by spurts and in response to some particular incentive. In this case the impetus was furnished by the new methods of blood and urine analysis, introduced by Folin and his co-workers, which in a short time have found such wide application. Nitrogen partition in the urine and retention in the blood; urobilin index of erythrocyte destruction; differentiation and prognosis in renal and cardiac conditions; sugar and acetone elimination in diabetes; hydrogen ion concentration of the blood in other conditions of acidosis—these are but types of the applications of quantitative chemistry to clinical diagnosis. Scarcely a month in which the journals fail to report another.

In this résumé no claim is made to completeness—still less to originality—of data. But it is hoped that from a somewhat panoramic view there may be caught a conception of the truly basal relationship of chemistry to medicine. It is for this collective concept that I bespeak the consideration which it has received of few chemists and still fewer physicians. To be sure, chemistry has long occupied a more or less perfunctory position in the curricula of medical colleges—becom-

[2] "As long as only qualitative methods are used in a branch of science, this can not rise to a higher stage than the descriptive one. Our knowledge is then very limited, although it may be very useful."—*Arrhenius.*

ing rather more than less perfunctory as the actual preparation of medicines, its most clearly recognized application, passed out of the hands of medical men. And chemistry is one of the subjects in which examination is required by official licensing boards. But it would require a most gifted intelligence to be able to deduce from the adventitious subject-matter of most of these examinations any suggestion that chemistry is a fundamental part of medicine rather than some extraneous attachment.

Let me explain what I mean by perfunctory position in the medical curriculum. Until the very recent general upheaval, medical instruction in all branches left much to be desired (to be conservative in expression). Rather than an exception to this statement, the old so-called "medical chemistry" was a glaring case in point. Crowded with descriptions of natural occurrences and methods of preparation of drugs, indications, effects and dosage, clinical symptoms of poisons and their laboratory detection—so much was usurped from the provinces of pharmacy, materia medica, pharmacology and therapeutics that little space was left even in the ponderous "Textbooks of Medical Chemistry" for references to fundamental chemical principles. When included at all these latter were carefully segregated within the paragraphs of their original mention—paragraphs which could be omitted quite as easily as those on the oxides of iodine without impairment to the continuity of the text. And in practise it would appear that these paragraphs on chemical principles were omitted with even greater facility.

We may well congratulate ourselves that "all that's put behind us," far away if not long ago. Instruction in chemistry in the medical colleges is now exclusively in the charge of full-salaried teachers, most of whom are trained chemists. Matters extraneous to chemistry are no longer allowed to preempt the place which belongs to the fundamentals of chemical theory and the present-day courses in chemistry, as given in most medical colleges, are of quite the same degree of excellence as those in other professional or academic institutions.

It is satisfying to regard this improvement, but facts are not wanting which raise other questions. May we still be lacking somewhat of the highest possible efficiency? In the Standards of the Council of Medical Education of the American Medical Association, defining the "Essentials of an Acceptable Medical College," this dictum is laid down, "Non-medical men should be selected as teachers in medical schools only under exceptional circumstances and only because medical men of equal special capacity are not available." The obvious advantage sought is the wider point of view of men trained to the practical applications of their subjects to other branches of medicine and able to direct the minds of students to these interrelationships. There is no department of instruction in which this advice of the Council has been so consistently disregarded as in the selection of chemistry teachers—and for the very good reason indicated, that "medical men of equal special capacity" were not (and are not) available. Medical instruction in chemistry is, therefore, for the most part in the hands of men adequately enough trained in chemistry but without formal education in medicine. As one of that very class, I venture to raise the question as to whether we have always sufficient catholicity. Is it not possible that we sometimes overlook the fact that we are training men to be physicians, not chemists? In our very righteous indignation at the inefficiency of the old "medical chemistry" may we not have swung the pendulum a little too far away from the point of practical contact?

To the last question it may be replied with perfect logic that when we have laid an adequate foundation of sound theory it is for the physiologist, the pathologist and the internist to build upon it according to the particular needs of his subject. But, like the gas laws, this logic applies strictly only under ideal conditions. As a practical fact the pathologists, internists, etc., concerned are not infrequently men who have succeeded less on account of any knowledge of chemical principles than in spite of the handicap of their inadequate instruction in that subject. Most of us have known chemists, the great men of a passing

generation, who having passed middle age before the advent of certain theories were entirely unable to use them in their reasoning although according formal acceptance. It were hardly fair to prescribe a more rigid requirement for our medical teachers of the present, though we may expect much more of those now in the making. In the meanwhile, shall the student be allowed to miss much which is essential because the chemistry teacher prefers to draw about himself the white mantle of pure science and pass by on the other side?

Another question occurs. By inference there has already been suggested a need for teachers trained both in chemistry and in medicine. The large number of published researches by "John Doe, Ph.D., and James Smith, M.D." suggests another field of usefulness for the man who can unite the training indicated by these two degrees, while the increased application of chemical analyses to clinical diagnosis is a third factor in creating a demand for such preparation. The last factor is worthy of some special consideration. This increased demand for chemical data in diagnosis is already marked, but it has only commenced. There must be men to do the work—and the practician is excluded. The methods concerned are quantitative and their usefulness depends upon the accuracy of the results. Even assuming the possibility of developing a quantitative conscience in a medical student within the available time, analytical efficiency can not be maintained by sporadic efforts—and the maintenance of regular quantitative work is incompatible with the practise of medicine. The requisite skill can be provided only by chemically trained men who give it their regular attention, and this is the way it is actually working out. The movement toward concentrating medical practise in hospitals is already well under way; an eminent authority has predicted that it will soon become universal. Already the hospitals are providing their corps of clinical chemists. Is it not time to make some special educational provision for the particular kind of combined training which will peculiarly fit men to discharge the functions of teaching, research and clinical control which have been indicated?

It may be suggested that adequate preparation for such work may be secured even now by pursuing the courses leading to the Ph.D. degree in chemistry and subsequently going on to the M.D. A few men do this and we recognize the *a priori* advantages which they possess over those who have only the one degree. But it is not economically sound to advocate this regimen for all who would so qualify themselves. Of the four years required for the medical degree (already it is five in those institutions which set the standards for to-morrow) more than half the time is devoted to the subjects of anatomy, surgery, obstetrics and minor allied subjects to which present or prospective chemical methods are only remotely related. It would appear both desirable and feasible to provide in our medical schools (or some of them) a special course for men already thoroughly trained in chemistry. Within two years could be compassed intensive courses in biology, physiology, advanced physiological chemistry, pathology, bacteriology and internal medicine with very brief attention to such portions of other branches as might appear desirable. With a bachelor's degree including as much chemistry as is now obtainable would it not be possible to arrange such a special course as suggested and, following this with a year of research, grant at the end of seven years the Ph.D., D.Sc., or a new degree of equal dignity?

A few years ago the Division of Organic Chemistry held a symposium upon methods of teaching that subject. If there are enough of the members of this Biochemical Division who are interested in the suggestions raised, or in allied considerations, it might be of advantage to provide at some future meeting for a similar free discussion of the whole matter. Out of such a frank canvassing of the situation there should come results which would enable the chemistry of the future to offer even more substantial contributions than the chemistry of the past has made to the science and art of medicine.

L. Junius Desha

Memphis, Tenn.

THE SCHOOL OF HYGIENE AND PUBLIC HEALTH AT THE JOHNS HOPKINS UNIVERSITY[1]

Our president, with a self-denial which I might appreciate, has intrusted to me the agreeable function of announcing upon this occasion one of the most important and gratifying gifts ever bestowed upon this university, a benefaction likewise of national interest. This is the provision of funds by the Rockefeller Foundation for the purpose of establishing in connection with the Johns Hopkins University a school of hygiene and public health. This action of the foundation was communicated to the trustees of the university only today shortly before these exercises. It is hardly necessary to add that the trustees have acted promptly in accepting this generous gift and have already taken the first steps toward organization of the new school in selecting Dr. Howell as the head of the physiological division of the institute of hygiene and to cooperate in the work of organization and development, and in appointing me as director.

It is expected that the school will be opened in October, 1917, as it is estimated that a year will be required for the planning, construction and equipment of the building and the gathering together of the staff of teachers. The necessary funds for construction, equipment, maintenance and expenses of the school will be provided by the Rockefeller Foundation.

When we consider the revolutionary discoveries of the last forty years in our knowledge of the causes and means of prevention of diseases, the great progress in the science and art of public health and the incalculable benefits to the community in the application of this knowledge, we can all realize the beneficent service rendered to this great cause by this latest gift of the Rockefeller Foundation, which has already contributed so largely to the advancement of medical science and education. Not only this university, but also this city and state and the whole country owe a great debt of gratitude to the foundation for the provision thus made of improved opportunities for training in preventive medicine and public health work and for cultivation of the sciences which find application in public and personal hygiene.

It is naturally most gratifying to us that Baltimore and the Johns Hopkins University have been selected for the location of the new school of hygiene and public health. Our city, in its situation, its relations to the south and other parts of the country, its proximity to the national capital, and its opportunities for study and work in the field of preventable diseases, is favorably located for such a school. I think that I may say that determining considerations have been the advantages arising from close association of the school with the medical school, the hospital, the school of engineering and other departments of the Johns Hopkins University, and it is for these reasons especially that the decision reached by the foundation after prolonged and careful study of the situation in different parts of the country is so gratifying to us. The wider extension of the influence and usefulness of the university, the possibilities of greater service to this city and state and to the country at large about to be opened by the new school, should materially strengthen the position of the Johns Hopkins University and aid in securing much-needed support in the development of other departments.

While the detailed plans of organization of the school of hygiene and public health will be worked out and announced later, a few points may here be touched upon.

Inasmuch as the profession of the sanitarian and worker in public health, although closely connected, is not identical with that of the practitioner of medicine, the school of hygiene and public health, while working in cooperation with the medical school, as well as with the school of engineering, will have an independent existence under the university coordinate with these schools. Opportunities in each will be available to students of the other schools.

The central and principal feature of the school will be an institute of hygiene housed in its own building, provided with the requisite

[1] Remarks by Dr. Wm. H. Welch at the commencement exercises of the Johns Hopkins University, as reported in the University Circular.

laboratories and facilities and with its own staff of teachers giving their entire time to the work of teaching and investigating.

There will be here laboratories of sanitary chemistry, of physiology as applied to hygiene —a most-important although much-neglected subject—of bacteriology and protozoology, and provision for epidemiology, industrial hygiene, vital statistics, a museum, library, etc. Additional facilities for instruction and research will be supplied by the medical and the engineering schools, the hospital, especially the newly opened wards for infectious diseases of the Harriet Lane Home for Invalid Children, and other departments of the university, which will be aided in undertaking the new work.

It is anticipated that mutually helpful relations will be established with our municipal and state departments of health, assurance of which has been given by our public-spirited mayor and other authorities, and with the federal public health service, whereby opportunities will be afforded for field work and other practical experience in various branches of public-health work.

Especially advantageous will be the relations with the International Health Commission of the Rockefeller Foundation, which is engaged in the study and control not only of hookworm, but also of malaria, yellow fever and other tropical diseases, which will receive due attention in the work of the institute.

It is intended that the school shall furnish opportunities of a high order for the cultivation of the various sciences which find application in hygiene, sanitation and preventive medicine, and for the training of medical students, engineers, chemists, biologists and others properly prepared who wish to be grounded in the principles of these subjects, and above all for the training of those who desire to fit themselves for careers in public-health work in its various branches—that most attractive profession for those qualified to practise it. The most urgent need at the present time is provision for the scientific training of prospective health officials and for supplementary and advanced courses for those already engaged in sanitary work. Suitable recognition of the satisfactory completion of work in the school will be given by the bestowal of certificates and degrees.

Directions in which it may be expected that the usefulness of the school of hygiene and public health will be extended are cooperative efforts with our training school for nurses and other agencies in the training of public-health nurses, who have become such important agents in voluntary and public-health work, and in the education of the public by exhibits, lectures and other means to a better application and understanding of the significance and needs of public and personal hygiene.

The dreams which many of us in the medical faculty have long cherished are now about to be realized. The opportunity which this great benefaction places in the hands of the Johns Hopkins University is most inspiring. It is comparable to that presented to the university at its beginning for the promotion of higher education, and later to the medical school and the hospital for advancement of the standards and methods of medical education. The responsibilities devolving upon the university in this new undertaking, entrusted to it with such high hopes, are commensurate with the splendid opportunities. May we not confidently anticipate that in this new field the results will be in keeping with the achievements of the university in the other fields it has cultivated so successfully?

THE NATIONAL EXPOSITION OF CHEMICAL INDUSTRIES

RECENTLY the managers of the Second National Exposition of Chemical Industries, at the Grand Central Palace, New York, during the week of September 25, had to arrange the second floor for exhibits, and now they report that there are but a few spaces still remaining on that floor.

To meet the requirements of the societies which will hold meetings at the Grand Central Palace the auditorium has had to be increased in size, so that now it will comfortably seat 500 persons. An automatic motion-picture machine of the latest design will be used to display the motion pictures, many of which

will be loaned by exhibitors. In many cases there will be lectures to take the audience through a pictorial tour of a plant and they will be shown machinery and processes in the manufacture of materials that, until then, had never been previously shown. Many of the films are at present being made and are expected to be finished in time to be shown at the exposition. A few of these films are as follows:

Making of Black Powder,
Manufacture of Iron,
Manufacture of Fertilizers,
Mining and Manufacturing of Iron,
Manufacturing of Silk,
Making of Blotting Paper,
Silver Mining,
Manufacturing of Varnish,
Asphalt.

Two other features of the exposition that have been added this year are a large section showing the opportunities that await the chemist in our south and known as the "Southern Opportunity" section and a section for the "Paper and Pulp Industry" composed of materials and machinery used in the manufacture of paper and other related products.

The "Southern Opportunity" section is an ambitious undertaking to display the latent wealth in the undeveloped resources of the south. It will show that the materials have formerly been shipped to foreign countries to be enhanced in value by manufacture and returned to the original producers at a greater price.

The Bureau of Mines is preparing an elaborate exhibit that will cover much space—it will be a working exhibit, one where the visitor can see the "wheels go round."

The exposition will be opened by Dr. Charles H. Herty, president of the American Chemical Society and chairman of the exposition advisory committee. Mr. Francis A. J. Fitzgerald, president of the American Electrochemical Society, and Arthur B. Daniels, president of American Paper and Pulp Association, will also make addresses.

The American Chemical Society, whose annual meeting is being held during the week and in conjunction with the exposition, has arranged for conference meetings at the exposition. Other meetings of the society will be held at Columbia University, at the College of the City of New York and the Chemists Club.

The Chemists Club, which is a few squares from the Grand Central Palace, has been selected as the headquarters of the American Chemical Society, and on Monday afternoon the council of the society will hold a business meeting there, followed by a dinner tendered to the council by the New York Section.

The American Electrochemical Society has arranged a series of meetings beginning on Thursday morning, September 28, with the "Made in America" technical session at the Grand Central Palace. This session will be devoted to papers and discussions on the varied electrochemical industries of America, followed on Friday morning by another technical session, devoted to the theoretical side of electrochemistry. Registration will be on Wednesday evening at the exposition, headquarters of the society being at the Electrochemical Society booth.

The Technical Association of Pulp and Paper Industry, which is also holding meetings in conjunction with the exposition, is arranging headquarters in the midst of the "Paper and Pulp Industry" Section on the second floor of the Grand Central Palace. A large number of interesting papers are promised on the technical aspects of pulp and paper manufacturing. On Friday morning the meeting will be held in the auditorium at the Grand Central Palace, and the afternoon meeting will be a joint conference with the American Chemical Society.

The members of the American Chemical Society and the American Electrochemical Society will receive badges which will admit them to the exposition without further tickets.

SCIENTIFIC NOTES AND NEWS

Sir T. Clifford Allbutt has been elected president of the British Medical Association. A message of congratulation was at the time sent to him on the attainment of his eightieth birthday which occurred on July 20.

SIR NORMAN LOCKYER has been elected a foreign honorary member of the American Academy of Arts and Sciences.

THE Paris Academy of Sciences has voted to confer its Delalande-Guerineau prize on Sir Ernest Shackleton.

PROFESSOR C. F. MARVIN, chief of the Weather Bureau, and Dr. L. O. Howard, chief of the Bureau of Entomology, have been appointed by the secretary of agriculture to represent the U. S. Department of Agriculture on the Council of Research which is being organized by the National Academy of Sciences.

THE forty-fourth annual meeting of the American Public Health Association will be held in Cincinnati, October 24 to 27, under the presidency of Dr. John F. Anderson, of New Brunswick, N. J., formerly assistant surgeon general of the United States Public Health Service.

DR. EMERY R. HAYHURST, of Columbus, has resigned as chief of the bureau of occupational diseases of the Ohio State Department of Health, to accept the assistant professorship of industrial hygiene in the Ohio State University. Dr. Roscoe P. Albaugh succeeds Dr. Hayhurst as chief of the bureau of occupational diseases.

THE Chicago commissioner of health has appointed a committee to undertake research on infantile paralysis. The members are: Dr. M. Herzog, chairman, and Drs. K. Meyer, H. B. Thomas, A. Hoyne and A. K. Armstrong.

J. N. B. HEWITT, of the Bureau of American Ethnology, is continuing this summer his ethnologic researches among the Iroquois tribes.

VAN H. MANNING, director of the bureau of mines of the department of the interior, visited Seattle on August 14 for the purpose of determining whether the experimental mining and metallurgical station to be established in the northwest by the federal government should be in Seattle. Dean Milnor Roberts, of the college of mines of the University of Washington, has offered the facilities of his college for use by the station and has asked that the station be located on the university campus. Mr. Manning also inspected other possible locations for the station.

DR. W. A. MURRILL returned on August 21 from a vacation of two weeks spent in the Catskills, at Arkville, Delaware County, New York, where he obtained about 400 numbers of fungi for the New York Botanical Garden herbarium. Arkville is of special interest to botanists in New York City because it is included in the local flora range and furnishes many species found in the Adirondacks.

THE George Williams Hooper Foundation for Medical Research of the University of California has sent a member of its staff, Dr. Ernest Linwood Walker, associate professor of tropical medicine, to South America, to carry on investigations as to tropical diseases on the upper reaches of the Amazon. He will be stationed for most of the year 1,500 miles up the Amazon, in the region of Porto Zelho, Rio Madeira, Amazon, Brazil. For his researches as to parasitic infections of man he is to have the privileges of the hospital maintained there by the Madeira-Mamora Railroad, of which the medical director is Dr. Allen M. Walker, a graduate of 1907 of the University of California Medical School.

A CABLEGRAM to the press from Buenos Aires reports that Sir Ernest Shackleton left Punta Arenas, Chile, on August 26, on board the ship *Yelcho,* to make a third attempt to rescue the members of his expedition marooned on Elephant Island.

AT the meeting of the American Chemical Society, to be held in New York, from September 25 to 30, the program will include a symposium on occupational diseases which will be presided over by Professor Charles Baskerville, head of the department of chemistry of the College of the City of New York. Among the topics which will be discussed are the chemical trades, prophylaxis in chemical industry, diseases incidental to work in aniline and other coal tar products, cedar lumber, mines and explosives. There will be a general discussion, the speakers including Dr. W. Gilman Thompson, of New York; Dr. F. L. Hofman, Dr. J. W. Schereschewsky, G. P.

Adamson, H. K. Benson, W. A. Lynott, Alice Hamilton and J. B. Andrews.

Dr. Charles Lincoln Edwards, director of nature study in the Los Angeles Public Schools, gave an illustrated lecture on the evening of August 16 before the California Academy of Sciences on his experiences in the Bahama Islands.

The eighth biennial vacation course in connection with the School of Geography at Oxford was held this year between the 3d and 18th of August. The opening address was given by Dr. Keltie on "The Progress of Geography in the last half-century and its present position."

At the annual meeting of the British Pharmaceutical Conference, held on July 12, Dr. David Hooper devoted his presidential address chiefly to an account of the drug resources of India and the British colonies.

Arthur Marion Brumback, professor of chemistry in Denison University since 1905, died on August 12, aged forty-seven years.

William Scrugham Lyon, known as an authority in botany and horticulture in the Philippine Islands, died on July 20, in Manila. Mr. Lyon served at one time as head of the California State Board of Forestry. In 1902 he went to the Philippines for the Bureau of Agriculture. In 1905, he left this bureau to engage in the business of collecting and exporting orchids, in which he continued until the time of his death.

Professor Scott, of the electrical engineering department of Robert College, Constantinople, has been killed by contact with a wire carrying 10,000 volts.

Dr. J. A. Harvie-Brown, a Scottish landed proprietor and ornithologist, died on July 26, at the age of seventy-two years.

Among deaths in the war announced in *Nature* are: C. M. Selby, formerly assistant naturalist in the Dublin National Museum; A. St. Hill Gibbons, known for his geographical explorations in Africa; Arthur Poynting, only son of the late J. H. Poynting, F.R.S., an engineer; and George Andrew Herdman, only son of W. A. Herdman, F.R.S., who, though only twenty years of age, had published investigations on biological problems.

The death is announced of Dr. Alexandre Layet, formerly professor of hygiene at Bordeaux, and correspondent of the Paris Academy of Medicine.

According to the report presented to the British Medical Association, more than 400 British physicians have lost their lives at the front in the past twelve months.

Twenty graduates of American universities left Paris for the front on August 16, as members of a newly formed section of the American ambulance field service.

The sum of $50,000 has been given by Mrs. Streatfeild, to be held in trust jointly by the Royal College of Physicians of London and the Royal College of Surgeons of England, for the promotion of research.

It is announced that the present Lord Avebury has handed to the British Museum authorities, for retention in the national collection or distribution among provincial museums, certain portions of the late Lord Avebury's collection of prehistoric and ethnographical specimens from various parts of the world, use of which was made in the writing of "Prehistoric Times." The gift includes a fine series from the early Iron Age cemetery at Hallstatt, Upper Austria, which will be kept in the British Museum, but many of the stone implements are available for distribution.

Regulations for enforcement of the new federal migratory bird law have been approved by President Wilson and now are effective. Shooting is prohibited between sunset and sunrise. Insectivorous birds are protected indefinitely, and no open season is allowed. Band-tailed pigeons, cranes, wood ducks, swans, curlew, willet, upland plover and smaller shore birds are protected everywhere until September 1, 1918.

In his address at the anniversary meeting of the Royal Geographical Society, Mr. Douglas Freshfield gave some details in regard to the map of Europe and the Nearer East on the 1:1,000,000 scale. Twenty-two sheets of the map have been compiled by the society

and reproduced and published by the geographical section of the general staff; eighteen sheets have been compiled and are in process of reproduction, while seventeen others are in a more or less advanced state of preparation. The scope of the map has been extended northward to the North Cape and the new Russian port of Alexandrovsk, eastward to Baghdad and the Caspian, and southward to Cairo and the head of the Persian Gulf.

The fifth Brazilian Geographical Congress will, as we learn from *Nature,* be held at Bahia on September 7–16. There will be twelve sections, devoted respectively to the following subjects: Mathematical Geography (astronomical geography, topography, geodesy); Physical Geography (aerology, oceanography, geomorphology); Physical Geography (hydrography, potamology, limnology); Vulcanology and Seismology; Climatology and Medical Geography; Biogeography (phytogeography and zoogeography); Human Geography; Political and Social Geography; Economic and Commercial Geography, including Agricultural Geography; Military and Historical Geography; Teaching of Geography, Rules and Nomenclature; Regional Monographs.

Among the forthcoming publications announced by the University of Chicago Press are the following:

The Control of Hunger in Health and Disease, by Anton J. Carlson.

Finite Collineation Groups (The University of Chicago Science Series), by Hans F. Blichfeldt.

Parallaxes of 27 Stars, by Frederick Slocum and Alfred Mitchell.

Second-year Mathematics for Secondary Schools, by Ernst R. Breslich.

Agricultural Economics, by Edwin G. Nourse.

The Psychology of Religion, by George A. Coe.

Truancy and Non-attendance in Chicago, by Sophinisba P. Breckinridge and Edith Abbott.

The Electron (The University of Chicago Science Series), by Robert Andrews Millikan.

Quarter-centennial Bibliography of Faculties, by a Committee of the Faculty of the University of Chicago.

That 1915 was the most successful year of production in the history of the petroleum industry is shown by statistics just compiled under the supervision of J. D. Northrop, of the U. S. Geological Survey, Department of the Interior. The total quantity of crude petroleum entering the world's markets in 1915, which amounted to 426,892,673 barrels, exceeds the former record, established in 1914, by 28,194,307 barrels, or 7 per cent. The bulk of the increase in 1915 came from the United States and Mexico, though Russia, Argentina and Japan recorded significant gains. The distribution of this production is shown in the following table:

Country	Barrels of 42 Gallons	Per Cent. of Total
United States	281,104,104	65.85
Russia	68,548,062	16.06
Mexico	32,910,508	7.71
Dutch East Indies	12,386,808	2.90
Roumania	12,029,913	2.82
India	7,400,000	1.73
Galicia	4,158,899	.98
Japan and Formosa	3,118,464	.73
Peru	2,487,251	.58
Germany	995,764	.23
Trinidad	750,000	.18
Argentina	516,120	.12
Egypt	221,768	.05
Canada	215,464	.05
Italy	39,548	.01
Other	10,000	
	426,892,673	100.00

The twenty-seventh annual conference of the Museums Association was held in Ipswich on July 10–12, when, as we learn from *Nature,* the following institutions were represented by delegates: (1) Five national museums—the British Museum, the British Museum (Natural History), the Victoria and Albert Museum, the National Museum of Wales, and the Museums of the Royal Botanic Gardens at Kew; (2) two London museums—the Horniman Museum and the Wellcome Historical Medical Museum; (3) the following twenty-five provincial museums and art galleries—Brighton, Bristol, Carlisle, Chelmsford, Derby, Dundee, Exeter, Halifax, Hastings, Hull, Ipswich, Leicester, Lincoln, Liverpool, Merthyr Tydfil, Newbury, Norwich, Perth, Peterborough, Plymouth, Reading, Salford, Warrington, Worcester and Worthing; and (4) the Museum of the University of Manchester. After a welcome by the mayor of Ipswich, the president, Mr. E. Rimbault

Dibdin, curator of the Walker Art Gallery, Liverpool, addressed the delegates, taking as his subject the effect of the war upon the art museums of the country. He had sent a series of questions to eighty-two art museums in Great Britain, and from their answers was able to give some interesting details as to their experiences. Briefly summarized, his remarks indicated that whereas several London galleries have been closed by the action of the government, and one or two others report a reduced attendance, the majority of the provincial institutions show an increased attendance, and only one has been closed. It thus appears that the protest lodged with the prime minister by the Museums Association against the government retrenchment committee's suggestion that provincial museums and art galleries should be closed has been thoroughly justified.

At the coming convention of the American Electrochemical Society which will be held in New York from September 27 to 30, one of the sessions will be devoted to "Made in America" products of the electric furnace and electric cell. These products include many of our most important staples such as copper, aluminum, abrasives, bleach and many more. It is an interesting fact that whereas other chemical industries, such as the coal-tar dye industry are primarily European, the electrochemical industry is largely American. It is here that the production of aluminum was invented and put on a commercial basis. The first plant for the electrical synthesis of the elements of the air and the production of artificial fertilizer nitrate was erected at Niagara Falls. At the Falls, also, tons of abrasives are produced in large powerful electric furnaces. The importance of these abrasives can best be appreciated by the fact that if these supplies were to cease to-day practically every mill and factory in the country would have to shut down within three months' time. Other electrochemical products of decided economical importance and value are graphite, phosphorus, hypochlorite of lime, magnesium, metal, carbon bisulphide, calcium carbide, hydrate of sodium, ferro silicon and other iron alloys which are indispensable to the steel trade.

We learn from the London *Times* that the British Advisory Council for Scientific and Industrial Research announces that it is appointing standing committees of experts to report on proposed researches of great importance submitted to it. Committees in mining and metallurgy have already been formed, consisting both of scientific men and of leaders of the industries concerned. Each committee will have two sections. Sir William Garforth, the coal owner, is chairman of the mining committee and of its nonmetals section, and Mr. Edgar Taylor, of the firm of John Taylor and Sons, owners of mines in various parts of the world, will preside over its metals section. Sir Gerard Muntz, of the Muntz Metal Company (Limited), Birmingham, has accepted the chairmanship of the metallurgy committee and of its non-ferrous section, and Sir Robert Hadfield, F.R.S., of Hadfield's (Limited), Sheffield, is chairman of its ferrous section. A similar committee for engineering is contemplated. The council is making grants to various societies to enable them to continue researches already in progress for which the necessary staff and equipment are obtainable, and quite recently valuable results have been obtained from researches connected with the production of optical glass. The council has also recommended a grant in aid of an important new research into the manufacture of hard porcelain, especially for domestic purposes. This has been undertaken by the Stoke-on-Trent Central School of Science and Technology, and the Staffordshire Potteries Manufacturers' Association, with a view to establishing the manufacture of hard porcelain in this country. Particulars have been obtained of the research work, not only of the scientific and professional societies, but also of the universities and higher technical schools, with a view to establishing a register of research. The possibility of collecting information under the seal of confidence as to the research work of particular firms is also being considered. The training of an adequate supply of research workers will be an important branch of the advisory council's work. It is impossible to announce definite

plans during the war, but the council has already made recommendations which, if adopted, will, it believes, secure that all that is practicable in existing circumstances shall be done.

UNIVERSITY AND EDUCATIONAL NEWS

AN endowment of $70,000, to create the "Howison Foundation," has been given to the University of California by George Holmes Howison, professor of philosophy, emeritus, in the University of California, and Lois Caswell Howison, his wife. Subject to an annuity during their lifetime, the endowment is to maintain the Howison Traveling Fellowship, of $1,200 to $1,500 a year, $600 a year to constitute the Lois Caswell Fund for the Dean of Women to aid deserving women students, and three or four Anne Sampson scholarships or fellowships, in honor of Mrs. Howison's mother, for women students in English literature and criticism.

DR. ALICE ROHDE has been appointed instructor in research medicine in the George Williams Hooper Foundation for Medical Research of the University of California. A graduate of the University of Chicago of 1903 and of Johns Hopkins Medical School of 1910, Dr. Rohde has had special training in research medicine under Professor Walter Jones and Professor J. J. Abel at the Johns Hopkins University and under Dr. Emil Fischer at Berlin.

DR. JOSEPH H. GROSSMAN, of Cleveland, has been appointed lecturer on diagnosis of tuberculosis in the school for applied social sciences of Western Reserve University.

AT the last meeting of the corporation of the Massachusetts Institute of Technology the following assistant professors were promoted to be associate professors: Daniel F. Comstock, theoretical physics; George L. Hosmer, topographical surveying; C. L. E. Moore, mathematics; Ellwood B. Spear, inorganic chemistry; William E. Wickenden, electrical engineering. The following instructors were made assistant professors: James M. Barker, structural engineering; Ralph G. Hudson and Waldo V. Lyon, electrical engineering, Earl B. Millard, theoretical chemistry; Thomas H. Huff, aeronautical engineering.

MR. T. E. GORDON has been appointed professor of surgery in Trinity College, Dublin, in succession to Professor E. H. Taylor.

PROFESSOR J. J. VAN LOGHEM has been appointed to the newly founded chair of tropical hygiene in the University of Amsterdam.

DISCUSSION AND CORRESPONDENCE

AMBLYSTOMA NOT AMBYSTOMA

TO THE EDITOR OF SCIENCE: In a letter printed in SCIENCE for June 30, 1916 (43: 929), Dr. M. W. Lyon, Jr., presents and defends the thesis, "*Ambystoma* not *Amblystoma*." If so, the spotted salamander has another spot on his name. *Ambystoma* is a dark saying. Dr. Lyon refers to the original paper of the author, Tschudi, 1839 (Scudder gives 1838), and says that the name is "written by him *Ambystoma* in four different places in his work, and only in that manner." He adds: "The derivation of the word is not given by him, and there is nothing to indicate that he intended *Amblystoma* and made a lapsus calami."

But outside of Tschudi's print, there *is* something to indicate that he intended *Amblystoma*, and made a lapsus of some sort; namely, the fact that *Ambystoma* has no assignable meaning in any known language, while *Amblystoma* has an assignable meaning in the language of science—that European or cosmopolitan Latin which has supplied the main vocabulary of science, and will probably supply it for ages to come; being, like the rustic's indefluent river, *in omne volubilis aevum*.

In this voluble vocabulary *Amblystoma*, or the adjective latent behind this name, means "having a blunt mouth." In form and meaning it is parallel to *Amblystomus*, the name of a genus of beetles, and to *Amblyrhynchus*, the name of a genus of lizards—which are cousins, once removed, of salamanders. These are but three of a long string of zoologic names beginning with *Ambly-*. But *Ambystoma* stands alone, though it appeared in the same decade with most of the others.

Whether *Amblystoma*, with the sense "having a blunt mouth," is an accurate or a suita-

ble name for the hapless salamanders to which it, or *Ambystoma,* has been applied, is a separate question.

If the framer of the word which first appeared as *Ambystoma* did not state the intended formation or the intended meaning, and if his description does not give a clue, it was a case in which science, for once, made a mistake—it left uncertain what it might have made certain.

One must guess, or reason out, what the author meant. His hand wrote—what? His printer printed *Ambystoma.* He printed it four times, we are told; but the second, third and fourth times may merely prove the meticulous care of the printer to repeat the first error, and thereby to secure that pleasing uniformity of error which is the undying passion of that deserving tribe. (What the tribe deserves I will not here disclose.)

Now, any scientific gentleman who thinks that it is a proper plan to form, print or defend a word *Ambystoma,* as a name for even the humblest of God's creatures, ought to consider whether he can "get across" with it. He may, indeed, find champions among his learned associates, especially among those to whom a printed error in a scientific work, if made early in the morning (I allude, of course, to one aspect of the rule of priority), has a Mohammedan or Shakespearian sacrosanctity; and some of these champions may try to support the error by daring flights into the clouds of etymology; as, in this case, the attempt mentioned by your correspondent, to support *Ambystoma* by capturing as its source a Greek phrase that is erroneous in itself, is nonexistent (except in the clouds), and could not without violence be persuaded to assist in forming such a word.

The fact that this imagined Greek phrase is in Science printed with one error in each of its three words, exonerates the printer from the censure of Mohammedan superstition. If I were to repeat the phrase here, he would be quite willing, I am sure, to oblige us with other variations. The printer of Tschudi was more rigid: "What I say *four* times is true."

But supposing that *Ambystoma* does not mean anything, what of it? Are we not often told that a name in zoology need not mean anything—that it may be a mere label, like a number?

This answer, however, does not meet the point. Names that *seem* to be formed from the Latin or Greek vocabulary in the usual manner will for ever be compared with their apparent sources; and anomalous names like *Ambystoma* or *Liopa* or *Fedoa* will for ever be challenged by scholars; and no agreement by a committee to take the first form found in print, or to acquiesce in de-facto fictions, will settle the question or the questioning. *Ambystoma,* so printed, *seems* to be intended for a word of the usual Latin and Greek vocabulary; but it means nothing, and it looks as if it were an error for *Amblystoma;* and to that form Agassiz corrected it.

I will not dwell upon the fact that *Amblystoma,* though a deliberately corrected form, is itself, considered as a neuter noun requiring a neuter specific adjective (*Amblystoma maculatum*), etymologically incorrect. But this point has been ignored in the framing of many New Latin names: and to consider it here were perhaps to consider it too curiously. Nevertheless, a fact ignored is still a fact *there.*

Ambystoma, then, it seems, has no right except the right of having started wrong. But the right of having started wrong is a right which the world is much disposed to admit. This is the case with many respectable sects and parties that have continued long upon the wrong road, and now obey at eve the erring voice which they obeyed at prime; or hold extra conventions to ascertain their principles. Whatever *was,* is right. Personally and scientifically, I do not believe this; but it is evident that many persons find a satisfaction in dogmas of literature and zoology, and in names and forms of words, that arose in former times. The glamour is in the preterition. These things *were.* That is something. The past, at least, is secure. Such things have a history; and they are at any rate free from the vice of being up to date.

It should be noted that the difference between *Ambystoma* and *Amblystoma* is not,

really, a difference of "spelling." *Scimitar, simitar, simiter, cimiter,* are four out of more than thirty spellings of one word, and *amoeba* and *ameba* are two spellings of one word; but *Ambystoma* and *Amblystoma,* whatever their status may be in zoology, are either two different words, or else two forms, one erroneous, of one word. No one asserts that they are two different words. All who have spoken agree that one is an erroneous form of the other. Which was intended? Let it be decided.

In all scientific compound names, intention is supposed to be present; and for this reason it will always be necessary that "science" shall correct what "science" has erroneously published; in other words, that Jones and Robinson shall correct the errors of their distinguished predecessors Brown and Smith. This is good science, and good fun, too, for Jones and Robinson. What but this, indeed, is the progress of science?

Is there not a scientific error in the attitude of those scientific men who prefer to take the first form and "have done with it"? Can science have done with anything? What the advocates of priority do is, in fact, to turn over an unfinished job to other men. This is reasonable enough, if they will let the other men finish it.

It were to be wished that the advocates of rule in zoologic nomenclature would play one game or the other—either the good old Presbyterian euchre, in which words are borrowed or manufactured orthodoxly from Greek and Latin sources (admitting, also, some heathen of the better sort), or else the less exacting Mohammedan solitaire, whose first law is the chance priority of print. It is hardly fair to mix with cards bearing the good old Presbyterian names of *Amblycephalus, Amblychila, Amblycorypha, Amblyopsis, Amblyrhynchus,* and the rest, a card bearing the Mohammedan and solitaire appellation of *Ambystoma.* (I am assuming that euchre and solitaire are played with cards.)

If this isolated *Ambystoma* is correctly formed, tell us how it is done and what it means. And then throw it out, nevertheless; for the scientific reason that it would be ever confusable with the similar-seeming words with which, on the Mohammedan theory, it has no connection.

Notwithstanding all the politic reports and mosaic codes of the committees on nomenclature, committees which have done an inestimable service to science, and which should be liberally supported by money and advice (two sources of enrichment, of which one will never fail), I hold that it is the duty of scientific men to correct the errors which they find within their own domain; or at least not to enforce or prolong any error, great or small, by devotion to any rule of priority or any other hand-made rule intended to serve convenience in registration, regulation, indexing or proofreading. It is not right to make a rule out of chance and to call it a rule of order. It is not right to set up priority, which is a part of history, and to call it science, which is a part of reason.

If we will use the language of science, we must apply the science of language. And we must not ignore or reject that science on the ground that "the authorities differ" or that "the doctors disagree." Let me end with a hard saying: The doctors do not disagree. It is only some writers and advisers and committee men who disagree. The rest of us are agreeably unanimous. Let every man of science place his hand upon his heart, and agree!

CHARLES P. G. SCOTT

YONKERS,
July 28, 1916

AMBYSTOMA

IN connection with Professor M. W. Lyon, Jr.'s note on "*Ambystoma* not *Amblystoma,*" I may mention the fact that Dr. Willard G. Van Name used *Ambystoma* as the scientific generic name of the spotted salamander in Webster's "New International Dictionary" which was published in 1909.

F. STURGES ALLEN

THE LIME REQUIREMENT OF SOILS

TO THE EDITOR OF SCIENCE: At this time when methods for the determination of the lime requirement of soils are receiving much

attention it is desired to point out several improvements in the lime-water method, as described in *Journal of the American Chemical Society, 26,* p. 661.

It has been found that to "draw off" the supernatant liquid and boil it to a volume of about 5 c.c. may lead to errors of 200 or 300 parts per million, because traces of soluble alkaline lime salts may not diffuse into the upper portion of the supernatant liquid. The method has been modified to read

. . . allow to stand over night, with occasional shaking, shake thoroughly and filter immediately through a neutral filter paper (S. & S. 588 is good) rejecting the first 10 to 15 c.c., or until the filtrate is quite or nearly clear, place in a Jena (Nonsol or Pyrex, or other insoluble glass may be used) beaker. . . .

I have realized from the first that the lime-water method gives high results on soils very rich in organic matter. One of the reasons for this was recently observed by Mr. Holman, of this laboratory. It is that the characteristic pink color developed when phenolphthalein is added to an alkaline solution is often almost immediately destroyed rather than masked in solutions containing much dissolved organic matter.

The error which may be thus introduced is lessened but not entirely eliminated by boiling down the filtrate to about 10 c.c. and adding, watching carefully meanwhile for the temporary pink color, the phenolphthalein a drop at a time.

This is not the only cause for the high results obtained on soils rich in organic matter. Other causes, modifications to eliminate them and improvements simplifying and shortening the method, will be presented at an early date.

F. P. Veitch

Washington, D. C.

THE SURVIVAL OF BEAT IN THE REMOVED HEART OF THE SNAPPING TURTLE

The aim of the present note is to place on record the details of the survival of pulsations in the heart of the snapping turtle. A specimen having a shell-length of about twelve inches was captured in the vicinity of Kingston by one of the boys of the community. For three days it was kept in a tub without food and on the fourth was killed and dressed "to make a stew." The writer was not present at the killing which occurred at 9:45 in the morning. The heart was brought to the laboratory at 10:45, the boy being interested in the fact that the beating continued. At the time the writer first observed the specimen it was lying in a small pool of blood in a saucer with the vessels cut short. It was then beating strongly at the rate of eleven times per minute. At 11:35 the blood was washed out of the saucer and normal salt solution added to partly cover the organ. The further record of the beats per minute was made as follows, the room temperature being 73° F.

9:45	..............turtle killed.
10:45	..............rate 11 beats.
11:05	..............rate 12 beats.
11:35	..............rate 12 beats.
12:30	..............rate 16 beats.
1:00	..............rate 18 beats.
1:30	..............rate 18 beats.
2:00	..............rate 18 beats.
2:30	..............rate 18 beats.
3:00	..............no contractions.

From the above it will be observed that the contractions continued at a slightly increasing rate for a period of about six hours. At the end of this time mechanical stimulus failed to produce further contractions.

Philip B. Hadley

Kingston, R. I.,
June 27, 1916

QUOTATIONS

SCIENTIFIC SOCIETIES AND THE GOVERNMENT

The letter in the *Times* of Professor E. G. Conklin, of Princeton, pointing out that no president has given such generous recognition to the National Academy of Sciences and other scientific bodies as Wilson, deserves larger attention than it will get. It occurs to few that the government could make profitable use of scientific auxiliaries. Though the National Academy of Sciences was authorized fifty-three years ago by Congress, in response to a demand by Alexander Bache, superintendent of the Coast Survey, for an official organization for research; though it was launched with a membership including Agassiz, Davis,

Gray, Dana, Guyot, Peirce, Joseph Henry and Hilgard; and though it has numbered the best American scientists since, it has made little popular impression. Professor Conklin states that Wilson was the first president to ask its advice in appointing an expert—following its recommendation in choosing the chief of the Weather Bureau. Again, though the American Society of Naturalists and the American Society of Zoologists had appealed in vain to McKinley to appoint a trained man commissioner of fisheries, Wilson not only promised to do so, but named the man they recommended. He has also followed expert advice in choosing the chief chemist of the Agricultural Department and the chief of the Bureau of Mines; and has entrusted to the National Academy the important work of establishing a national research council.

The fact that the National Academy of Sciences has lagged behind the similar academies of Europe is traceable to various causes. One lies in the huge extent of our country, making difficult the frequent assembling of scientists at Washington, as they easily gather at London, Paris and Berlin. Our scientists are usually connected with universities scattered over the whole land, while in Europe the most important seats of learning are often situated at the capitals. But a main cause is clearly the lack of government support. The academy has had to rely for its work on money given by Bache, Agassiz, C. B. Comstock, Wolcott Gibbs, Apthorp Gould, Sir John Murray, and others, totalling only about $200,000—part of this to be devoted to prizes. It has had no home, and its building fund would disgrace any vigorous college fraternity. It has not received the number of commissions for the government—to be executed with government funds—that it might very well have had; and in some years has been almost inactive. It was once given such tasks as to suggest a means for restoring the Declaration of Independence, to canvass the various materials for cent coins, to show how to prevent counterfeiting, to offer a tariff classification of wools, to study glucose manufacture: tasks that would now be handed over to the government's own scientific bureaus. Only recently has it seemed that it may soon assume its proper place as a chief federal agency in many lines of research.

The Royal Society of Britain and the French Academy of Sciences are great institutions that this country can not at present equal. For two centuries they have been the centers of progress in research. The first had its period of weak governmental support, when it was too poor to publish Newton's "Principia," but it now has $20,000 a year and special grants, its own quarters, and the building formerly known as its workshop, now as the Royal Institution. Here have worked Faraday, Davy, Young, Tyndall, Dewar, Sir Joseph Thomson and others, many as brilliant in the lecture room as in research. It has supplied money and instruments to scientific expeditions all over the world, has assisted the self-governing dominions and India, and has performed such special tasks as that allotted the Sleeping Sickness Commission. The French Institute, set firmly on its feet by Colbert and Napoleon—the latter was a member—has had names as great, and at one period surpassed the best days of the Royal Society, with Laplace, La Grange, Becquerel, Fourier, Regnault, Gay-Lussac, Berthollet, Cuvier, Lamarck and Saint-Hilaire on its rolls. Our National Academy would do well if some day it rivalled that of Berlin, with its large new building, ample funds and tradition of consistently maintained research into Greek and Latin inscriptions, the Prussian law, and the history of the fixed stars; or if it became as important to America as the Stockholm Academy, which distributes the Nobel prizes, is to Sweden, or that at Petrograd to Russia. It must be given more of such work as it has had in reporting on a national board of health, on a plan for treating the national forests, on the survey of the territories, or on Philippine exploration. And it must somehow find funds to enable it to carry on extended researches in one field for years, and to undertake publishing, as do the European bodies.

If the National Academy were often consulted by the president about scientific appointments, we should only be following a

precedent long established in France. Whenever a professorship falls vacant there in one of the national universities, or the directorship of an observatory, or a similar post, the Academy of Sciences is asked to recommend a first and second choice to the proper officer —as the minister of public instruction. Our executives will never surrender a wide latitude of choice, but President Wilson has set a good example. So, too, his action in asking the academy to study the slides at Panama, and to form a body which should bring all the research agencies of the country into a position to cooperate with each other and the government in time of need, indicates a praiseworthy intention to heighten the prestige of the academy.—New York *Evening Post*.

SCIENTIFIC BOOKS

Meteorites, Their Structure, Composition and Terrestrial Relations. By OLIVER CUMMINGS FARRINGTON, Ph.D., Curator of Geology, Field Museum, Chicago. Published by the author.

The mystery attendant upon the fall of a stone-like or metallic body upon our earth from the "realms of space" early attracted the attention of students of natural phenomena and aroused the curiosity and perhaps superstition of the uneducated. Singularly enough, however, the literature upon so fascinating a subject has, so far as the English-reading layman is concerned, for a long time been very unsatisfactory, consisting mainly of brief papers descriptive of individual occurrences, or catalogues of collections. The well-known books of Kirkwood and Lockyer treat the subject mainly from an astronomical standpoint. Fletcher's "Introduction to the Study of Meteorites," a British Museum publication, has been by far the most satisfactory treatise, but is scarcely known outside of the libraries of the specialist. In other languages we have Meunier's handbooks and treatises based on the collections of the Paris Museum, Brezina's on those of Vienna, and lastly Cohen's comprehensive "Meteoritenkunde," a work altogether too detailed and technical for the general reader. The book of Dr. Farrington, here under review, comes, therefore, opportunely into a field where there is plenty of room. In an octavo volume of 225 pages is given as fully as space will permit, a summation of present knowledge regarding *Meteorites, their structure, composition and terrestrial relations*. The leading chapters deal with the phenomena and time of falls, the size and form of individual meteorites, their structural features, chemical and mineralogical composition, origin and classification, with a final chapter on the principal public collections. From this last it appears that the collections of the British Museum, those of Vienna and Paris abroad, and of the Field Museum in Chicago, comprise each representatives of some 600 out of the known 634 falls and finds, the rapid growth of the last named collection being due to the acquisition of the Ward-Coonley collection in 1912. The national collections at Washington, numbered, as shown by a recent "Handbook and Descriptive Catalogue," 412 falls and finds (since increased to some 432), including the recently acquired "Shepard Collection." This wide distribution of the material from individual falls is worthy of more than passing notice. Prior to the eighteenth century, it seems such objects were rarely preserved in museums, or if so preserved, were hidden away, the custodians fearing to make themselves ridiculous by even acquiescing in their supposed ultra-terrestrial origin, and it was not until the publication of the works of Chladni in 1794 and 1819 that their accumulation for study began upon a truly scientific basis.

The earliest known undoubted meteorites still preserved are those of Elbogen, Bohemia, and Ensisheim, Upper Alsace, Germany, dating back to 1400 and 1492. These have been broken up and scattered throughout public and private museums the world over, Wulfing's catalogue showing that fragments of the Ensisheim stone are to be found in 66 different collections. It is sometimes questionable if the almost fanatic desire on the part of private collectors to secure fragments, however small, has not retarded rather than helped the cause, since it has not merely re-

sulted in hopelessly scattering the material, but has enabled dealers to enforce prices in many cases absurdly high and actually prohibitive so far as acquisition of material for analysis and study is concerned. The writer can speak feelingly on this point. To illustrate: A recent catalogue of a Philadelphia dealer advertises a perfectly commonplace type of meteoric stone at $5.00 a gram, the only possible excuse being that there was not much of it, and in falling it passed through the roof of a barn! Even higher prices have been recorded as paid by those whose chief aim appears to have been numbers and a new fall to add to their lists. The largest single individual meteorites in any collection in the world are those of Cape York, Greenland, and Willamette, Oregon, in the American Museum of New York.

From a consideration of the dates of all known falls it appears that such are most frequent in the months of May and June, the periodic star showers of August and November notwithstanding. Further it appears that of the 273 falls concerning which satisfactory datum is found, 184 occurred between the hours of noon and midnight, and 89 from midnight to noon.

Some interesting facts are brought out in the chapter on distribution, it being shown, apparently, that falls are most numerous in mountainous regions, as those of the southern Appalachians in our own country, or the Alps and Himalayas in Europe and Asia. The suggestion that this may be due to superior gravimetric attraction can not, however, for a moment be accepted; moreover, the reviewer can but feel that something is wrong in the premises, since but two falls can be credited to Switzerland, with its Alps, while the flat plains of Kansas have thus far yielded seventeen. It is of further interest to note that of the total of 634 known meteorites, 256 have been found in Europe and 117 in the United States, or more than two thirds the whole number from less than one eighth of the land surface; and still further, that of the 328 from the eastern hemisphere, 299 are stone and but 79 iron, while of the 256 from the western hemisphere, but 74 are stone and 182 iron. Whether these seeming anomalies have any meaning or are due merely to accident of find, the future must decide.

In the discussion of the origin of meteorites the author gives adherence to the theory that they are portions of a shattered planet or planetoid, and is apparently favorably inclined to the views of Chamberlin—to a probable source of disruption by differential attraction produced by the passage of a small body within Roche's limit of a larger one. In the chapter on terrestrial relations, comparison in chemical composition is made between the average composition of four meteorites, the acidity of which is above normal, and the average composition of terrestrial rocks. The reasons for the selection of but these four meteorites are not quite acceptable to the reviewer, but, incidentally it may be remarked that, in consideration of the question of the origin of the earth through an accumulation of meteoric matter, one is not necessarily led to the consideration of one so fluid as to become homogeneous throughout; indeed, Chamberlin recognizes the possibility of a relatively cold earth. In this case certainly the portions now available for study should conform within reasonable limits to that of the ingathered matter. That they do not conform to that now being ingathered, the reviewer has shown elsewhere. Is it not better to account for this on the very reasonable supposition that the materials now being ingathered do not represent in composition those which fell during the later periods of earth history, rather than ignore the extremely basic character of most meteorites and use for comparison only the four acidic types selected?

The book, to cut the review short, shows a thorough knowledge of the results achieved by other workers, and forms a very welcome addition to existing literature. It is well illustrated by half-tone figures of form and structure, those of microstructure being reproductions from Tschermak's well-known "Mikroskopische Beschaffenheit der Meteoriten."

GEO. P. MERRILL
U. S. NATIONAL MUSEUM

Theory of Errors and Least Squares. A Text-book for College Students and Research Workers. By LeRoy D. Weld, M.S. New York, The Macmillan Company, 1916. 8vo. Pp. xii + 190.

The two pages of "Preface" of this book made a very unfavorable impression on the reviewer. It would take too much space to point out the expressions that seemed catchy but meaningless or non-committal. It gave the impression that possibly the author had not caught the fundamental purpose and nature of the method of computation discussed in the volume. The idea of having the theory for its amateurish "satisfaction" and of getting it "in an evening or so and then put it into immediate practise" did not at all harmonize with the reviewer's knowledge that only a fairly experienced observer has much real use for the method of least squares in his computations.

As a text-book for "undergraduates," unless they are classed with the "casual readers," it presupposes a half-year at least of training in the calculus. Compare pages 54, 57, 60, 67, 71, 90 and others. Any student of the desirable amount of inquisitiveness would like to know under what conditions and to what extent he may play such tricks of the calculus as he sees, *e. g.,* following equation (h) on page 181; and it would take considerable advanced calculus to make it all clear to him.

As a book for "handy reference" it would be vastly more useful by having a carefully prepared, detailed index. This need is partially met by "Appendix F. Collection of Important Definitions, Theorems, Rules and Formulas for Convenient Reference," pp. 185 sq. Throughout, references are made to Article, Equation (number), or even to Chapter, without adding the page, which would facilitate the use of the book, since only page numbers appear on the tops of the pages. It would help much to have the number of the page on which each formula originally appears given as well as the number of the formula on pp. 188–190, and elsewhere.

Happily, the "Preface" is the poorest part of the whole book and that may be omitted by the reader. On pages 17 and 28 the author states clearly the "special office of the method of least squares," yet he nowhere emphasizes the fact that he is dealing with a method of *computation.* He does not make use of the splendid opportunity of forcing and fixing upon the attention of the reader the facts that the method does not improve the quality of poor or careless observations, and that only the beginning student carries readings as of grams out to six or seven decimal places (see any reference to grams, *e. g.,* p. 155). It further would not be difficult and much worth while to point out that in the formula $y = ce^{-h^2x^2}$ (24), p. 56, the exponent must be an abstract number so that $1/h$ and x must be measures in the same unit. The types of readers for whom the book is intended are the very ones that should have these matters indelibly impressed upon them. Although it is sometimes stated that illustrations are from students' work, it is passing strange that the author should have let such matters escape his notice.

Barring two cases of questionable English, pp. 65, 170, that only a purist might notice, the book is quite free of errors of speech and of typography. The treatment is remarkably clear and well-ordered. The topics are nicely correlated. Especial attention should be called to Chapters IV. and VIII., and to Art. 27 of the former chapter in particular. Lucid is not too strong to describe some portions of the book. On the whole, readers who want only a general idea of what the theory is about can scarcely find a more concise and clear presentation for that purpose. The numerous, excellent, well-chosen exercises at the end of each chapter will, if solved, greatly enhance the permanent value of the book.

The adverse criticism is herein placed first so that the reader may finish the review with the desire to get and read the book, and find it as interesting and profitable as the reviewer has found it.

Charles C. Grove

ARISTOTLE'S ECHENEIS NOT A SUCKING-FISH

In the course of a rather extensive series of researches on the shark-sucker, it has been

found necessary to trace this fish back to Aristotle, the Father of Natural History, with the interesting result that it has become very evident that Aristotle's *Echeneis* was not a sucking-fish at all.

The first reference in question is in the "Natural History of Animals," Book II., 14; 505 *b*, 19–22; and, as rendered in Professor D'Arcy W. Thompson's scholarly translation (Oxford, 1910), it reads:

> Of fishes whose habitat is in the vicinity of rocks, there is a tiny one, which some call the *Echeneis* or shipholder. . . . Some people assert that it has feet, but this is not the case: it appears, however, to be furnished with feet from the fact that its fins resemble these organs.

A fair acquaintanceship with the sucking-fish and a somewhat extensive reading of the literature fail utterly to substantiate these statements. It is true that, blindly following Aristotle, a number of the medieval writers on natural history, or more properly pseudo-natural history, speak of the *Echeneis* as given to laying fast hold on to rocks at the approach of storms and staying there until the return of fair weather. St. Ambrose in his "Hexameron," written in the fourth century A.D., seems to have been the first to set forth this story of the *Echeneis* as a rock-holder and weather prophet. However, this is plainly an echo of Aristotle and there is no ground whatever, so far as I know, for any such belief, or for thinking that it dwells among rocks.

Further, it is not a "tiny fish." Adult Echeneises run in size from 15 to 36 inches, and adult Remoras from 10 to 15 inches in length. It might be well just here to state that *Remora* is not only the smaller of the sucking-fishes, but is generally of a dark uniform brown color. *Echeneis,* on the other hand, is not only much larger, but is of a slaty-brown or black color, and is easily recognized by the broad black stripe edged with white extending from the angle of the mouth back through the eye along the mid-lateral line to the base of the caudal fin. Both fishes have on the top of the head and on the back-of-the-neck region a haustellum or sucker made up of the modified spinous dorsal fin. This sucker consists of a circumferential rampart of soft tissue forming an ellipse divided into compartments by numerous crosswise partitions and having a single lengthwise partition running from end to end in the longest diameter of the ellipse, which is also the median dorsal line of the fish. This sucker is under muscular control, and when applied flat to an object and then raised a partial vacuum is created and the sucking-fish clings fast.

Last of all, no sucking-fish has fins even distantly approaching the form of feet, the pectoral and pelvic fins being of the ordinary teleostean type and showing no special modification whatever. Many authors have thought that in this last sentence Aristotle was describing an Antennariid fish, of which the Sargassum fish, *Pterophryne histrio,* not uncommon in our waters, is a good example. Such fish have the pectoral fins modified to form organs not superficially unlike a hand. However, in endeavoring to identify Aristotle's fish we must take into consideration his whole description. His fish I believe to have been a goby, for the following reasons: gobies are "tiny fish which live among rocks," and which have their pelvic fins united to form a cup-like adhesive organ, which is placed on the thorax, in order that they may adhere to the rocks among which they live.

In another place, however, Aristotle does refer to a fish which in my judgment is an *Echeneis,* or sucking-fish, though he does not he writes:

> In the seas between Cyrene and Egypt there is a fish that attends on the dolphin, which is called the "dolphin's louse." This fish gets exceeding fat from enjoying an abundance of food while the dolphin is out in pursuit of its prey.

This fish Professor Thompson identifies with the pilot-fish, *Naucrates ductor,* which is represented in our Atlantic coastal waters by the very beautiful little Carangid fish, *Seriola zonata.* This "dolphin's louse," however, I identify as the sucking-fish. The first evidence to be presented is found in the context. This last reference to Aristotle comes in a section given over to a consideration of various sucking parasitic insects, lice, ticks, fleas, etc., and

ends with a description of those crustaceans parasitic on fishes to which the name "sea lice" is given. This internal evidence certainly lends itself to the view that the dolphin's louse was a sucking fish.

In working up the literature, two references of marked interest just here have been found. Hasselquist, the friend and pupil of Linnæus, in his "Reise nach Palæstina" (published in 1762) refers to an *Echeneis neucrates* (an old spelling of *naucrates*) collected at Alexandria and records that the Arabic fishermen there called it *Chamel el Ferrhun*. This term Dr. Frank R. Blake, of the Johns Hopkins University, very kindly translates for me as the "louse of the terrible one"—*i. e.*, a shark.

Another like name is to be found in the writings of another eastern traveller, Forskål, likewise a pupil of Linnæus. He collected on a shark at Djidda, a town situated about half way down toward Aden on the eastern shore of the Red Sea, an *Echeneis neucrates* which the natives there called *Kaml el Kersh*, and which he translates the "louse of the shark." Dr. Blake kindly writes me that this term is more properly to be rendered "the louse of the fish of prey" (which Forskål tells us was a *Carcharias* shark). From all of which we see that in the east, where habits and customs and even names change slowly, the sucking-fish was still called "the louse" some 2,000 years after Aristotle.

We now come to the most interesting point of all in this discussion, which is that if one reads Aristotle closely he will be convinced that the Father of Natural History never saw the shark-sucker. Aristotle's descriptions of other fishes are very clear, evidencing keen powers of observation, and it is not to be thought that, having ever seen and examined the sucking-fish, he could have failed to give an explicit description of the sucking disk. Note also that his words are ". . . which some call the *Echeneis* or ship-holder." He is quoting from some one else and in the judgment of the present writer never saw the *Echeneis*.

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SPECIAL ARTICLES

ANTAGONISM AND WEBER'S LAW

When toxic substances act as antidotes to each other this action is called antagonism. It is usually found that when antagonistic substances are mixed in various combinations there is one proportion which is more favorable than others. If this favorable proportion be maintained it is well known that considerable variation in the concentration of the antagonistic substances is permissible for many plants. It has been pointed out by the writer[1] that while variations in concentration affect the form of the antagonism curve they do not in general affect the proportions which are most favorable for life processes.

It is therefore evident that if we wish to preserve the favorable character of a mixture when the concentration of any antagonistic substance is increased we must at the same time increase the concentration of the others in the same proportion. The law of direct proportionality found in such cases is in reality Weber's law, as Loeb[2] has pointed out in discussing his experiments on animals. In regard to the significance of this Loeb says:

> Since this law underlies many phenomena of stimulation it appears possible that changes in the concentration of antagonistic ions or salts are the means by which these stimulations are brought about, as suggested by my ion-protein theory and by the investigations of Lasareff.

In view of the importance of these relations it seems desirable to ascertain, if possible, what mechanism exists which makes one proportion better than others and preserves this preeminence in spite of variations in concentration.

The writer has formulated a theory[3] involving precisely this kind of mechanism. According to this theory the electrical resistance and the permeability of protoplasm are determined by a substance M which is formed and decomposed by the reactions

$$A \rightarrow M \rightarrow B$$

Under normal circumstances M is formed as

[1] *Botanical Gazette*, 58, 367, 1914.
[2] *Proc. Nat. Acad. Sciences*, 1: 439, 1915.
[3] *Proc. Am. Phil. Soc.*, 55, 1916.

fast as it is decomposed and its concentration remains constant. But under unfavorable conditions the decomposition of M proceeds faster than its formation; this results in injury and, if carried far enough, in death.

The processes which produce this result in such solutions as mixtures of NaCl and $CaCl_2$ are checked by a salt compound[4] of the type Na_2XCaCl_4 formed by the reversible reaction

$$2NaCl + X + CaCl_2 \rightleftharpoons Na_2XCaCl_4,$$

in which X is a constituent of the protoplasm.

The amount of this salt compound formed in each mixture of NaCl + $CaCl_2$ can be calculated by the formula

$$K = \frac{\text{Conc}_{Na_2XCaCl_4}}{(\text{Conc}_{NaCl})^2(\text{Conc}_{CaCl_2})(\text{Conc}_X)}$$

In pure NaCl the amount of Na_2XCaCl_4 will be zero, but if increasing amounts of $CaCl_2$ be added the amount of Na_2XCaCl_4 will increase to a maximum and then decline until it again reaches zero in pure $CaCl_2$.

Let us assume that the maximum amount of Na_2XCaCl_4 is found when the molecular proportions[5] are 95.24 NaCl + 4.76 $CaCl_2$. It is evident that we can get this same amount in a different mixture (*e. g.*, 50 NaCl + 50 $CaCl_2$) by increasing the absolute concentrations of NaCl or $CaCl_2$. We should therefore get an equally favorable result in both cases: but this is contrary to the results of experiment. If the phenomena of antagonism really involve a salt compound like Na_2XCaCl_4 it is evident that some mechanism must exist which insures that an increase in the total concentration of salts will have little effect as compared with that produced by a change in their relative proportions.

It is easy to see that such a mechanism must exist if the formation of Na_2XCaCl_4 takes place at a surface. In a surface substances usually exist in a different concentration from that which they have elsewhere in the solution. If NaCl and $CaCl_2$ migrate into the surface, so as to become more concentrated there than in the rest of the solution, their concentration in the surface must increase, as their concentration in the solution increases, up to the point where the surface is saturated. Beyond this point an increase in their concentration in the solution produces no effect on their concentration in the surface. When this stage has been reached the formation of Na_2XCaCl_4, if it takes place in the surface, will not be affected by an increase in the concentration of the salts in the solution. It will, however, be affected by changes in the relative proportions of the salts. The number of molecules in a unit of surface will remain nearly constant, but if the proportion of NaCl in the solution be increased some of the $CaCl_2$ in the surface will be displaced by NaCl.[6]

Below the saturation point the relative proportions of the salts will be of less importance than their total concentration: this is the case at low concentrations in the region of the so-called "nutritive effects."

It is evident that if we adopt this theory we can see why the most favorable proportion must remain approximately the same in spite of variations in concentration. We thus arrive at a satisfactory explanation of Weber's law.

It is evident that Weber's law will not apply when the concentration is below the saturation point. On the other hand at high concentrations effects of osmotic pressure, coagulation, etc., may exert a disturbing influence.

Thus far we have discussed effects in which the criterion of antagonism is electrical resistance or permeability. But it has been shown by the writer that electrical resistance and permeability are very accurate and sensi-

[4] The actual proportion of Na and Ca in this compound may be supposed to differ according to the proportion of these substances in the most favorable mixture. In place of Na and Ca we may have other antagonistic salts, and more than two may enter into the compound.

[5] These are the proportions found in an investigation described in *Proc. Am. Phil. Soc.*, 55, 1916.

[6] It may easily happen that NaCl and $CaCl_2$ do not migrate equally into the surface. If we assume that 10 times as much $CaCl_2$ enters the surface as NaCl we shall find the maximum amount of Na_2XCaCl_4 in 95.24 NaCl + 4.76 $CaCl_2$. (*Cf. Proc. Am. Phil. Soc.*, 55, 1916.)

tive indicators of vitality. It therefore seems highly probable that the theory here presented may be applied in those cases where other criteria of antagonism (such as motion, growth and length of life) are employed.

It will be seen that action in a saturated surface is the essence of this explanation. It is evident that so long as this essential feature is preserved it makes little difference what theory of antagonism we adopt. If the antagonistic substances act in a saturated surface antagonism must be governed by Weber's law.

Summary.—The fact that Weber's law governs antagonism is explained by a dynamical theory formulated by the writer.

This theory assumes that injury and death result from processes which are inhibited by salt compounds formed by the union of salts with the protoplasm. If these compounds are formed in a surface the amounts will (above a certain limit) be independent of variations in concentration and will depend only on the proportions of the antagonistic salts. From this it results that Weber's law must govern the phenomena of antagonism.

No matter what theory of antagonism we adopt, it is evident that if the antagonistic substances act in a saturated surface antagonism must be governed by Weber's law.

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DO FUNGI LIVE AND PRODUCE MYCELIUM IN THE SOIL?

The recent investigations on soil microorganisms have revealed the fact that fungi are found in soils in very large numbers sometimes reaching as high as 1,000,000 per gram of soil. These numbers are found by diluting the soil and then plating out only a small portion of a gram. The colonies developing on the plates represent the spores or pieces of mycelium found in the soil. But this does not tell us about the actual active life of the fungi in the soil. However large the numbers that are found, it remains to investigate whether those organisms existed in the soil only in the form of spores, which were brought in by some outside agency, or are a result of active life in the soil in the form of mycelium which may or may not result in the formation of spores in the soil. The question is not how many numbers and types of fungi can be found in the soil, but what organisms lead an active life in the soil. To what depth are these organisms found to produce mycelium in the soil? And finally, do all or at least most of the organisms isolated from the soil actually produce mycelium in the soil?

At the suggestion of Dr. Charles Thom, of the Bureau of Chemistry in Washington, a direct isolation of fungi producing mycelium in the soil was attempted. Soil samples taken at different depths, under absolutely sterile conditions, were brought into the laboratory; lumps of soil, about 1 cm. in diameter, were transferred with sterile forceps into sterile plates containing cooled sterile Czapek's solution agar. The lump was placed carefully in the center of the dish, which was immediately covered and allowed to incubate for 24 hours at 20–22° C. After this period mycelium was found to radiate out of the lump of soil into the medium. This mycelium was now transferred with a sterile platinum loop to sterile slants of Czapek's agar, care being taken to select the tips of the hyphæ so as not to bring the loop in too close contact with the soil. The agar slants containing the transferred portions of mycelium were allowed to incubate till the organisms had developed well and were ready for study. The organisms thus isolated were not always pure. They had to be often separated from one another; this was accomplished by establishing pedigree cultures of the organisms.[1]

The organisms thus isolated are believed to come from the mycelium that is actually found in the soil. The period allowed for the incubation of the soil in the petri dish was not long enough for spores in the soil to germinate and produce such a mass of mycelium; this is espe-

[1] The methods of isolation and establishment of pedigree cultures, as well as the details of the work, formulæ for media used and identification of organisms will be published later.

cially true, since the medium used for incubation (Czapek's agar) is very unfavorable for the development and growth of the Mucorales, the group of organisms which had most representatives among the fungi isolated by the method previously described.

Organisms Found	Soils Used							
	Garden[2]	Orchard	Meadow	Forest	Iowa	Cranberry	Oregon	Dakota
Mucor plumbeus (Bonorden)	+[3]	+	+	+				
Mucor racemosus (Fres.)......	+		+	+		+	+	
Mucor circinelloides (Van Tiegham)..	+	+	+	+		+	+	+
Mucor hiemalis (Wehmer).....	+		+				+	
Zygorhynchus vuillemnii (Namys.)	+	+	+	+	+			
Rhizopus nigricans (Ehrbg.)..		+	+		+	+	+	
Green Trichoderma..............	+	+		+	+	+		
Penicillium luteum (Zukal)...						+		
Penicillium sp........................						+		
Fusarium sp.................... ..	+		+				+	
Sporotrichum sp.....			+					
Acrostalagmus albus (Preuss.).	+						+	
Cephalosporium acremonium (Corda).........................			+				+	
Zygodesmus sp....................							+	
Sclerotium.....................					+		+	+
Sterile White Mycelium.........	+		+	+	+	+	+	+

To establish the fact whether the mycelium transferred, after the soil was allowed to remain in contact with the sterile medium, came from spores or from mycelium in the soil, the following test was made. A series of sterile plates containing cool, sterile Czapek's agar were incubated with spores and portions of mycelium from several organisms. The spores were had by shaking some spore material with 50 c.c. sterile water, then dipping a sterile platinum needle into the liquid and passing it over the surface of the sterile medium, thus dropping the single spores. The mycelium was transferred directly with a sterile needle from the culture upon the plate. The organisms used for this test were several Mucors, Trichodermæ and Penicillia. After twenty-four hours' incubation at 20–22° C. the plates were examined. Those that were inoculated with the mycelium had quite an extensive growth, the tips of the hyphæ being about as distant from the center of inoculation as in the case where the soil was used as an inoculum. But on the plates where only spores were inoculated very minute colonies could be observed with the naked eye; upon placing the dish under the microscope and examining it with the low power, one could see these colonies forming from each spore along the trace left by the needle in the medium. This fact gave reasons to believe that the mycelium developing on the plates from the soil came not from spores, but from organisms that actually live in the soil and produce mycelium there.

[2] The garden, orchard, meadow and forest soils came from the College Farm, New Brunswick, N. J., Cranberry from Jamesburg, N. J., the other four soils from the respective station grounds.

[3] Indicates presence of organism.

A number of soils of different origin, of different physical and chemical composition and treatment, were used for this investigation. The following table shows the occurrence of the different organisms in the soil, in the form of mycelium.

The results brought out in the above table are very interesting. Soils of entirely different textures, chemical and physical composition, soils widely apart from one another, contain many organisms which are alike for several of them. Of course, this refers only to the organisms that have been isolated by the above method and in the few soils studied. Other soils may contain different groups of organisms, as is found in the case of the Iowa and Dakota soils, where only very few organisms have been isolated by the direct method. It looks as if soils that are under a relatively similar range of conditions show, to a certain extent, similar groups of organisms when these are isolated directly from the soil.

Mucor circinelloides, Zygorhynchus Vuilleminii, green *Trichoderma, Rhizopus nigricans* and *Mucor racemosus* were found most abundantly. The *zygorhynchus* has been found at all depths from one to thirty inches below the surface, while most of the other organisms were isolated from the upper eight inches of soil. In most samples taken at depths of 12, 20 or 30 inches only *zygorhynchus* would develop from the soil upon the plate, with no other organism. The *sterile white mycelium*

developing from most of the soils is probably the mycelium of fleshy fungi. Other organisms, such as the *Penicillia, Fusaria* and *Sporotricha,* which are usually found in the soil abundantly when plated out by the dilution method, have been isolated by this method only in very few cases. The *Aspergilli, Alternaria, Cladosporia,* the great majority of the *Penicillia,* and other organisms commonly found in the soil, have not appeared on the plates in twenty-four hours, when the soil has been inoculated directly upon sterile medium.

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THE AMERICAN CHEMICAL SOCIETY. IV

DIVISION OF WATER, SEWAGE AND SANITATION

Edward Bartow, *Chairman*

H. P. Corson, *Secretary*

Sanitary Surveys as a Feature of Public Health Work: H. E. BARNARD.

Sanitary Survey Methods: J. C. DIGGS.

A Sanitary Survey of Logansport, Ind.: J. C. DIGGS.

Swimming Pool Sanitation: W. LEE LEWIS.

The Rate of Ammonia Distillation in Water: F. W. BRUCKMILLER.

A Modification of the Whipple Method for Direct Nesslerization: F. W. BRUCKMILLER.

The Determination of Carbonic Acid, Combined and Free, in Water: JOHN JOHNSTON.

The Numerical Treatment of B. coli Values in Water Analysis: EARLE B. PHELPS AND WILLIAM F. WELLS.

Development at Lawrence of the Process of Purifying Sewage by Aeration and Growths—Activated Sludge: H. W. CLARK.

This paper describes the discovery and development at the Lawrence Experiment Station of the Massachusetts State Department of Health of the method of purifying sewage by aeration and growths—a method known quite generally as the activated sludge method. The paper shows that the method was developed there in 1911 and 1912, was shown to Dr. Gilbert Fowler, of Manchester, Eng., in the fall of 1912 and that the English work was largely a repetition of the Lawrence work. It quotes from Fowler and from Ardern and Lockett, his colleagues, to prove that their activated sludge work was based upon the Lawrence work. The paper further gives the statement of Dr. McLean Wilson, of England, made in his presidential address to the Association of Sewage Works Managers. This statement is as follows:

> Many investigators, including Drown, Dupre and Dibdin, Mason and Hine, Black and Phelps, Fowler and others, had sought to purify sewage by direct chemical oxidation by means of air currents and had failed. At Lawrence, however, the efficiency of growths in the purification of sewage by aeration was discovered.

The paper further describes the Lawrence work during the past four years and the results of much of this work. These results show that sewage can be fairly completely purified by this method. The paper is concluded as follows:

> Finally, the governing factors in the success of this process of sewage treatment are, as I have stated in previous articles: (1) The cost of power for supplying the large volume of air necessary; (2) a sewage that readily yields itself to this method of treatment. It is not impossible to believe that certain sewages can not be purified in this manner.

Composition of the Effluent Air from an Activated Sludge Tank: F. N. CRAWFORD AND EDWARD BARTOW.

Experiments with Activated Sludge at Milwaukee, Wis.: W. D. COPELAND.

The Aeration of Sewage in the Presence of Activated Sludge from the Standpoint of an Engineer: E. J. FORT.

Activated Sludge Experiments at the Baltimore Sewage Disposal Plant: CALVIN W. HENDRICK.

Chemical Observations of the Activated Sludge Process as applied to Stock Yards Sewage: ARTHUR LEDERER.

The Activated Sludge Process: W. D. RICHARDSON.

The Sewage Experiment Station of the Illinois State Water Survey: J. F. SCHNELLBACH AND EDWARD BARTOW.

The Experiments with Activated Sludge at Brockton, Mass.: ROBERT SPURR WESTON.

Brockton, Mass., population 62,000, discharges an average of 2,100,000 gallons fine-screened sewage daily, two thirds on 30 acres of sand beds, one third on 0.5 acre trickling filter, followed by 7 acres of sand beds. Rates are low; efficiency also. Difficulty due to stale, strong sewage containing shoe factory waste and dyes. (Suspended solids 204, free ammonia 55.8, chlorine 138.6 p. p. m.) Plain aeration with and without contact followed by Imhoff tank and trickling filter treatment was tried in 1915 with unsatisfactory results. More aeration was required. Fill and draw activated sludge tank followed by sand bed at 500,000

gallon rate gave excellent results. Continuous process now being tried for clarification alone. Results good. Aeration period at least four hours. Complete nitrification never obtained by aeration even after 25 days. Nevertheless, activated sludge process alone offers relief to present overtaxed plant.

Some Results on the Treatment of Packing House Sewage by the Aeration Process in the Presence of Activated Sludge: PAUL RUDNICK AND G. L. NOBLE.

The Saving Effected by Using a Softened Water in Boilers: G. S. COTTER.

The Treatment of Industrial Wastes: HARRISON P. EDDY.

Some Studies on Chemical Self Purification in the Ohio River: EARLE B. PHELPS AND HAROLD W. STREETER.

Oxygen Demand Determination in the Field: F. W. BRUCKMILLER.

The Determination of Nitrates in Sewages by the Ortho-Toluidine Reagent: EARLE B. PHELPS AND H. L. SHOUB.

Studies on the Removal of Manganese from Water Supplies: H. P. CORSON AND EDWARD BARTOW.

The Value of Softened Water to a Railroad: R. C. BARDWELL.

Softened Water and Its Benefits in Laundry Work: JOHN H. RYAN.

Some Features of Swimming Tank Control: W. LEE LEWIS.

The American literature offers very little direct data on the epidemiology of swimming pools, though there is general expression to the effect that such pools may spread gastro-intestinal, respiratory and even venereal diseases if improperly controlled. The rotating or continuous filtration system maintains a more sanitary pool than intermittent filling. Both should be supplemented by daily sterilization. Pool water of Lake Michigan type, as shown mathematically and experimentally, should not be rotated under the conditions more than three months on account of decreasing alkalinity and increasing hardness.

DIVISION OF PHYSICAL AND INORGANIC CHEMISTRY

Irving Langmuir, *Chairman*

James Kendall, *Secretary*

The Chromic-Chromous Potential at Mercury Electrodes: GEORGE SHANNON FORBES AND H. N. RICHTER. (Lantern.)

Pure violet $CrCl_3$, partially reduced to $CrCl_2$ by purified hydrogen at 400° in quartz, was dissolved with stirring in ice-cold, tenth normal hydrochloric acid. The solution, filtered into the cell, was allowed to stand over pure mercury. If all operations were conducted in hydrogen or carbon dioxide absolutely free from oxygen, the potential rose throughout two days to a constant maximum, otherwise it fluctuated irregularly. Concentrations at equilibrium were determined analytically. Referred to normal hydrogen electrode as zero, with correction for junction potentials,

$$\pi = -0.400 + 0.065 \log \mathrm{Cr_{III}/Cr_{II}}.$$

On platinum potentials reached a maximum about 0.16 volt lower, with evolution of hydrogen.

Heterogeneous Equilibria between Aqueous and Metallic Solutions: A Study of Mixed Sodium and Potassium Salt Solutions at Total Concentrations varying from 0.2 N to 4.0 N: G. MCPHAIL SMITH AND T. R. BALL. (Lantern.)

The Contamination of Precipitates in Gravimetric Analysis: Solid Solution and Adsorption vs. Higher-Order Compounds: G. MCPHAIL SMITH.

An Electrically Controlled Calorimeter for Measuring Heats of Dilution: D. A. MACINNES AND J. M. BRAHAM. (Lantern.)

On the Evolution of the Elements according to the Hydrogen-Helium System: W. D. HARKINS. (Lantern.)

Theoretical Relations of the Atomic Weights: W. D. HARKINS. (Lantern.)

A New Gravimetric Method of Determining Aluminum, and of Separating that Metal from Zinc, Manganese, Nickel, Cobalt, Iron and Chromium: LOUIS KAHLENBERG AND K. P. YOUNG.

When ammonium salicylate is added to a dilute solution of an aluminum salt, and this solution is then boiled, there separates out in granular form a basic aluminum salicylate of the composition $(Al(C_6H_4{\cdot}OH{\cdot}COO)_3)_2{\cdot}Al(OH)_3$. This may be readily filtered off, washed with hot water, ignited and weighed as Al_2O_3. The precipitate is much more readily handled than the usual slimy and gelatinous precipitate of aluminum hydroxide. Zinc, manganese, nickel, cobalt, ferrous iron and chromium are not thus precipitated by ammonium salicylate, which fact is the basis for the direct and simple separation of these metals from aluminum. The solution should be fairly dilute, lest the basic aluminum salicylate occlude notable amounts of the other metals. If this should occur, redissolving the precipitate and then reprecipitating from the dilute solution will secure a good separation. Sodium salicylate may be used as the

precipitant instead of ammonium salicylate, but the latter is preferable.

The Electromotive Forces of Concentration Cells and their Relation to the Transference Number: D. A. MACINNES.

The Complete Solubility Curve of Calcium Carbonate: JOHN JOHNSTON.

The Specific Conductivity of Pure Water in Equilibrium with Atmospheric Carbon Dioxide: JAMES KENDALL.

An Apparatus for Determining Freezing-Point Lowering: R. G. VAN NAME AND W. G. BROWN.

The Colloidal Phosphates and Arsenates of Iron: HARRY N. HOLMES.

The Formation of Crystals in Gels: HARRY N. HOLMES.

The Potential of Iodine Concentration Cells: GRINNELL JONES.

A Supposed Effect of the Form of Container upon the Density of a Gas: WILLIAM A. NOYES AND LAURENCE C. JOHNSON.

In an effort to explain the difference in the volumetric ratio of hydrogen to oxygen in water as determined by Morley and by Scott, the volume occupied by a gas in a system of tubes has been compared with that occupied by the same mass of gas in a bulb. It has been shown that there is no difference in volume larger than one part in ten thousand, whereas the two determinations referred to differ by one part in one thousand.

A Demonstration of the Selective "Action" of Clay on Soluble Sulphides: JOHN C. INGRAM.

The Theory and Mechanism of Adsorption: IRVING LANGMUIR.

The Oxides of Iron. II. Magnetic Properties of the System Fe_2O_3-Fe_3O_4: R. B. SOSMAN AND J. C. HOSTETTER.

The Dissociation of Ferric Oxide in Air: J. C. HOSTETTER AND R. B. SOSMAN.

On the Measurement of the True and Apparent Electrical Conductivities of Solutions: Inductance, Capacity, Frequency and Resistance Relations: H. P. HASTINGS, W. A. TAYLOR AND S. F. ACREE.

Separation of the Elements of the Tin Group: J. M. WELCH AND H. C. P. WEBER.

A very characteristic combination of tin and antimony sulfide, which is always formed when tin and antimony are precipitated together, is utilized as an indication of the presence of these two elements. The compound formed, which is probably a salt of thioantimonic acid, has not been isolated as yet, but a few compounds of the type are known. The reaction is characteristic for all mixtures of tin and antimony lying between 1:20 and 20:1.

The procedure consists in obtaining this brown-black color reaction, redissolving the sulfides without separation, precipitating the antimony as sulfide from an oxalate solution and reducing the stannic chloride in the filtrate to stannous chloride with metallic lead.

The process described is shorter and its use by students has resulted in a material decrease in the number of errors (as shown by statistics) in the work done.

Differential Iodimetry. III. Determination of Vanadium in the Presence of Iron and Uranium: O. L. BARNEBEY.

Differential Iodimetry. II. Determination of Chromium in the Presence of Iron: O. L. BARNEBEY.

Precipitation of Magnesium Ammonium Orthophosphate: EDWARD G. MAHIN.

Some Laboratory Experiments on the Extraction of Radium from Carnotite Ores: A. G. LOOMIS AND HERMAN SCHLUNDT.

A System for Reports on Quantitative Analysis to be used in Teaching: E. GILL.

The Action of Anhydrous Aluminium Chloride upon Unsaturated Hydrocarbons: W. E. HENDERSON AND W. C. GANGLOFF.

The Determination of Solubility Curves by the Method of Flotation: W. E. HENDERSON AND GEBHART STEGEMAN.

Determination of Transition Points by the Measurement of Electromotive Force: W. E. HENDERSON AND I. W. GEIGER.

A Systematic Procedure for the Separation of the Anions: First Group: H. A. WINCKELMANN AND H. C. P. WEBER.

The problem of the systematic separation of acids, which has received very little attention in analytical methods, is an especially important one in connection with instruction in chemistry, and possibly of more importance generally than is realized. Actually, very little has been done in the subject.

By means of the plan outlined mixtures containing any or all of the radicals, ferrocyanide, ferricyanide, cyanide, thiocyanate, chloride, bromide, iodide, sulfide, in quantities varying from 0 to 100 mg. may be satisfactorily analyzed, and their amounts estimated. The steps can not well be presented in abstract, but the manipulations are the customary ones of qualitative analysis, the

successive reagents being zinc salts, silver salts, mercuric salts, alkaline formates, metallic copper and cuprous salts.

On Some Molecular Compounds in Glass: E. W. TILLOTSON.

On the Variable Rotatory Power of Dissolved Organic Substances: M. A. ROSANOFF AND H. A. MORTON.

On the Constant a of Van der Waal's Equation: M. A. ROSANOFF AND H. C. CORLISS.

On the Change of Transition Points with Pressure: M. A. ROSANOFF.

A Rational Process of Fractional Distillation: M. A. ROSANOFF.

A Study of Some of the Physical Properties of Mixtures of Dielectric Oils and Water. (Preliminary Report.): L. I. SHAW AND L. A. PAPPENHAGEN.

Change of Conductivity with Time in the System $MeOH + I_2$. (Preliminary Report.): L. I. SHAW AND J. P. TRICKEY.

Atomic Weight of Yttrium: C. W. BALKE AND B. S. HOPKINS.

The Potassium Iodide Reaction for Platinum: W. J. PRINCE AND H. C. P. WEBER.

The cherry-red, to rose, tint which is produced in platinum solutions by means of potassium iodide is one of the most sensitive tests known. Apparently well-suited for the purpose of colorimetric estimation of the quantity of platinum in solutions, the reaction has not been used for this purpose for lack of ability to properly control conditions.

This investigation shows that the resulting color is not the result of the formation of a reduction product, such as a platinous compound or of colloidal platinum. There is an intermediate formation of a complex iodide, and the water plays an essential part (hydrolysis) in the reaction since the color is not developed in certain other solvents. Immediately after development of maximum color intensity has been attained a colloidal phase can be distinguished in the ultramicroscope, but this is platinum iodide. The rate of the reaction is affected enormously by the quantity of KI present. If only theoretical proportions of this substance are added (6KI: 1 Pt) the reaction goes almost directly to black colloidal PtI_4. The reaction curves show that 4 to 5 times the theoretical quantities of KI are necessary to produce satisfactory results. As little as 2×10^{-7}g. Pt may be recognized in 1 c.c. of solution.

From consideration of the optimum conditions necessary for the production of the desired color reaction it is hoped that a colorimetric method for the estimation of Pt may be developed.

The Viscosity of Alcoholic Solutions: O. F. TOWER.

The Relation between Molecular Cohesion and Surface Tension. Eötvös Law: ALBERT P. MATHEWS.

Determination of Aluminium as Oxide: WILLIAM BLUM.

The various factors affecting the precipitation, washing and ignition of aluminium hydroxide in quantitative analysis were studied. By means of the hydrogen electrode it was found that the precipitation is complete at a point between the turning points of the indicators methyl red and rosolic acid, the use of which is therefore recommended. The conditions for the accurate estimation of aluminium are defined.

A Study of Tantalum Pentachloride for Atomic Weight Purposes: G. W. SEARS AND C. W. BALKE.

A Study of the Dialysis of a Colloidal Solution of Hydrous Chromic Oxide in Chromium Chloride: MARKS NEIDLE AND J. BARAB.

The Temperature Effect in Dialysis, and a Simple Rapid Dialyzer: MARKS NEIDLE.

Production of Triatomic Hydrogen by Radium Rays: G. L. WENDT.

The Effect of Dissolved Substances on the Velocity of Crystallization of Water: J. H. WALTON AND A. BRAUN. (Lantern.)

The Atomic Weight of Dysprosium: C. W. BALKE AND E. W. ENGLE.

Dysprosium material was purified by the alkali sulfate separation, followed by fractional crystallization of the bromates, ethylsulfates and nitrates. For the atomic weight determinations the oxide-chloride ratio was studied. Dysprosium oxide, Dy_2O_3, was placed in a tarred quartz flask, weighed, dissolved in HCl, and the chloride dehydrated, fused and weighed in the flask. Five consecutive determinations gave the values 164.354, 164.357, 164.116, 164.104, 164.207. Mean value 164.228. This is considerably higher than the value now in the International Table.

Potassium Lead Tartrate: R. S. DEAN.

The Density of Aqueous Copper Sulphate-Sulphuric Acid Solutions: H. D. HOLLER AND E. L. PEFFER.

The densities of solutions of copper sulphate and sulphuric acid varying in concentration from 0 to 20 per cent. of each solute, were determined at 25° and 40° C. The densities were found to be approximately additive, and to be dependent upon the total concentration of the two solutes.

An Electrical Insulating Material for Use in Moist Atmospheres: EDWARD W. WASHBURN.

Types of Wheatstone Bridges for Alternating Current Work: EDWARD W. WASHBURN.

Induced Reactions in the Analytical Chemistry of Lead: V. H. GOTTSCHALK.

An Attempt to Combine Nitrogen and Chlorine Directly: B. R. HONOVSKI, L. C. JOHNSON, F. O. ANDEREGG AND W. A. NOYES.

Pure nitrogen and chlorine are sparked in a glass apparatus, using gold tipped electrodes. Results vary from 0.2 mg. to 1.5 mg. of combined nitrogen on Nesslerizing. These values were checked by blank analyses at all times.

The Nernst Integration Constant in Gaseous Systems: N. HOWELL FURMAN.

Attention is called to the fact that owing to the lack of sufficient data concerning the specific heats of solids over wide range of temperature, and the absence of such data in the case of liquids, the rational vapor pressure formula,

$$lu\pi = -\frac{\lambda_0}{RT} + \int \frac{1}{RT^2} dT \int [\epsilon_p - c]dT + i,$$

can rarely be applied to the interpretation of vapor pressure measurements.

The Nernst approximation formula,

$$\log \pi = \frac{\lambda_0}{4.571T} + 1.75 \log T - \frac{\epsilon}{4.571} T + c,$$

is more generally applicable, but care must be exercised in its employment, otherwise the values deduced for the several constants will not possess any physical significance whatever.

These points were illustrated by numerical calculations.

The Reactivity of Acids: HUGH S. TAYLOR.

The Specific Heat and Specific Kinetic Energy of Elements and Compounds: J. E. SIEBEL.

After devising formulæ for the specific molecular kinetic energy increase, the author determines this and corollary quantities for representatives of different groups of gases and vapors. The tabulated results demonstrate the constancy of their molecular kinetic energy against the inconstancy of their molecular heat (Dulong and Petit product); they also yield the molecular velocity in harmony with Millikan's number of molecules, the relation of molecular velocity to sound propagation, the equivalent of volume- and kinetic-energy, etc. Accordingly these quantities appear as functions of the rectilinear, progressive motion of the molecules not dependent, that is not directly so, on other intermolecular-latent-disgregation- or rotary-energy.

Vapor Pressures of Ethyl Alcohol and Alcoholic Water Mixtures at 25° and Composition of Vapors in Equilibrium with the Mixtures: I. H. DERBY AND F. DANIELS.

Composition Dissociation in Concentrated Solutions of Sodium Chloride and Potassium Chloride: I. H. DERBY, D. MAYARD AND E. T. FEGON.

The Dissociation Pressures of Various Salt Hydrates and the Vapor Pressures of their Saturated Solutions: I. H. DERBY AND V. YNGVE.

The Swelling of Rubber in Various Liquids and the Nature of the Process: I. H. DERBY, P. D. SCHULTZ AND O. D. CUNNINGHAM.

A Study of 0.1 Normal HCl Calomel Electrodes: N. E. LOOMIS.

DIVISION OF PHARMACEUTICAL CHEMISTRY

John H. Long, *Chairman*

Geo. D. Beal, *Secretary*

The New Features of the U. S. P. IX.: JOSEPH P. REMINGTON. (Lantern.)

The Toxicity of the Volatile Principles of Coffee, with Comments on Coffee Substitutes: L. E. SAYRE.

The Pancreatin Tests of the Pharmacopœia: J. H. LONG.

Bennett: A Note and a Correction: HOWARD T. GRABER.

Pepsin: A Résumé of Tests: HOWARD T. GRABER.

Relative Toxicity of Different Species of Digitalis: ROBERT A. HALL, E. L. NEWCOMB AND R. E. MORRIS.

On the Apparent and Real Ash Content of Digitalis: NORBERT MUELLER AND EDWARD KREMERS.

Alkaloidal Assay by Immiscible Solvents: H. F. LEWIS AND G. D. BEAL.

The Preparation and Characteristics of Emetine: FRANK O. TAYLOR.

Some Unexpected Reactions in Pharmaceutical Mixtures: FRANK O. TAYLOR.

The Strength of Fluid Extracts: H. A. LANGENHAN AND EDWARD KREMERS.

On Tincture of Peppermint for Coloring Purposes: NORBERT MUELLER AND EDWARD KREMERS.

Further Notes on the Identification of the Emodin-containing Drugs: RUTH E. OKEY AND G. D. BEAL.

Determination of Small Amounts of Water and Alcohol in Ether for Anesthesia: E. MALLINCKRODT, JR.

The Detection of Minute Quantities of Unsaturated Hydrocarbons in Liquid Petrolatum: C. H. BRIGGS AND W. L. IRWIN.

CHARLES L. PARSONS,
Secretary

SCIENCE

FRIDAY, SEPTEMBER 8, 1916

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MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

THE INTERDEPENDENCE OF FOREST CONSERVATION AND FORESTRY EDUCATION

THE economic and industrial development of the western continent is comparatively recent. The abundance of the natural resources in the new world made the consideration of their exhaustion a subject of little public interest. The increasing rapidity in the depletion of these resources, particularly in the most populous and best industrially developed of the American republics, has within recent years emphasized the need of foresight in dealing with them.

The United States has been the foremost of the western nations in urging the conservation of national resources through better use and in enacting national and state laws regulating use. When a nation is new and sparsely populated the necessary encouragement for industrial expansion and increased population makes governmental regulation of forest and other natural resources less essential. There comes a time, however, in the life of every nation when future needs must be safeguarded from present private greed. When this time comes a change must be initiated in the method of handling these resources.

The recognition of this principle caused the United States in 1891 radically to change her policy regarding the unoccupied national domain and begin the establishment and organization of national forests. Prior to this time practically all of the forests in the entire country could be exploited without regard for a second crop, because nearly all timberland was

privately owned or else in the public domain open to sale or settlement. Fortunately, in the United States, when the policy of the public ownership of forest property was accepted, there were still large areas of public domain covered with timber from which national forests could be segregated without cost to the republic. Unfortunately these areas were chiefly in the western half of the country, consequently the national forests are, for the most part, located in the states west of the Mississippi River and remote from the best timber markets.

It is invariably the case that nations do not awaken to the need for forest conservation until too late to attain the best results without large expenditures of time and money. Thus, the United States in order to secure national forests in the eastern half of the country, where there is the greatest need for forest conservation and the orderly development of forest property, is forced to purchase from private owners timberland that never should have passed from public ownership.

The segregation of the national forests from the public domain during the past two decades has given us 162 national forests, having a total area of nearly 165 million acres. The more recent policy of purchasing timberland from private owners for national forests in the east has already resulted in the acquiring of nearly 386,000 acres in seven of the eastern states. About 900,000 acres additional have been approved for purchase. The fixed policy of the government relating to the management of the vast acreage in national forests is conservation through use, *i. e.*, the treatment of the property so that the yield will increase rather than decrease with use.

During the same period that the national government has been creating, organizing and developing national forests the state governments have been creating, organizing and developing state forests. At the present time, 14 states have a total of 147 state forests, which embrace an area of nearly 3,675,000 acres. New York with two large state forests of 1,825,882 acres leads all other states in the extent of her state-owned forests. Pennsylvania with 50 state forests of nearly 1,000,000 acres has done much more than the other states in the organization and development of them.

Counties, cities and towns have secured, chiefly within the past decade, communal forests varying from less than 100 acres in extent to more than 20,000 acres. Complete data relating to communal forests in the United States is not available. The states having the largest number of such forests are Massachusetts and New York. It is believed that there are, at the present time, from 200,000 to 300,000 acres of communal forests in the United States. These forests have, for the most part, been acquired for the purpose of protecting the watersheds from which potable water is obtained for the use of cities and towns. They are usually located in the vicinity of large centers of population where there is a demand for all classes of forest products, thus making the practise of intensive forestry possible.

The most interesting and far-reaching movement in forestry in the United States has been this movement toward public ownership of forest property. Approximately one fifth of the total area of the forests in the United States has been made into national, state and communal forests in the space of twenty years. The public has squarely faced the issue of forest conservation and has recognized the fact that it is not possible without the public ownership of forest property. Our forest policy is firmly anchored on the rock of public ownership that our forest resources can be made to continue indefinitely and not be-

come waning resources when increased population and industrial development make their need even more important than at the present time.

Four fifths of all the forests of the country are still in private holdings. They are in small holdings attached to farms or in larger holding in non-agricultural regions. The larger holdings contain more than three fifths of all the merchantable timber in the entire country. They are in the possession of individuals or corporations that have consolidated and brought together these large holdings in comparatively recent years, often at a large initial cost. This enormous body of virgin timber, because of the large carrying charges for interest, taxes and protection, must, from necessity, be forced on the market as rapidly as possible. This accounts for the small increase in stumpage values during recent years.

The quantity of standing timber in the hands of private owners is so large, the competition for a market is so keen, and the necessity for cutting is so imperative there is little likelihood for a marked advance in stumpage for many years to come. The inevitable result of this condition is the utter inability of the owners of more than three fifths of the merchantable timber to cut their stumpage in a manner that will insure a satisfactory second crop. The practise of forestry necessarily carries with it present expenditures far beyond those incurred in forest exploitation without regard for future crops. Only a small percentage of the private forests in the United States are so favorably located in reference to market that the value of all classes of stumpage is sufficiently high to make thinnings, reproduction cuttings, plantings and other operations concerned with the production of the crop profitable. For this reason forestry is not practised by private owners of timberland except on woodlots in strictly agricultural regions and in restricted areas of New England and elsewhere where there is an excellent local market for all classes of forest products.

Although, in most cases, the private owner can ill afford the present expenditures necessary to insure future crops and *will not make them*, the public can well afford to make such expenditures, and experience shows that *they do make them.* Thus, the administration of the national forests is spending on them nearly twice the present annual receipts. The public can well afford to make present expenditures in order to insure future crops of timber *because it is not only recompensed from the timber produced, but also by the indirect value of the forest to the entire community.* We should clearly appreciate the following fundamental truth: *It is the indirect value of the forest which accrues to the public at large that makes the practise of forestry economically possible by the public before it is possible by the private individaul.* The public can and should practise forestry, while the private individual seldom can economically, and will not. I, therefore, affirm that the practise of forestry in the United States really began with the creation of public forests. Its progress will be measured by the increase in area of such forests and the rapidity with which they are organized and orderly developed.

With this brief outline of our advance toward forest conservation, I now direct your attention to the intimate relation that forestry education bears to it. Forestry education was the fountain head from which sprang the beginnings of forestry in this country. Forestry education is the source from which flows all progress in forestry. It shapes and directs our forest policy and determines our methods of prac-

tise. Forestry education and forest conservation have moved forward together. Without the one the other would be impossible.

Forestry education began in the United States more than a century ago, but not in schools. It began with the first desultory efforts of a few far-seeing enthusiasts, who had a clear vision of the future, to interest the public in forest conservation. Little progress, however, was made until the early eighties when more systematic propaganda was undertaken. A forest commissioner was appointed by the United States Department of Agriculture. The importance of this office has steadily grown. In 1886 it became the Division of Forestry, in 1901 the Bureau of Forestry, and in 1905 the Forest Service. Practically all of the early work of this branch of the government service was educational in character, viz., *systematic propaganda showing the need for forest conservation*. Great assistance in this important movement was brought about in 1882 through the formation of the American Forestry Congress, which later became the American Forestry Association. The proceedings of this society contain the complete history of the progress in establishing our present forest policy. Its journal *American Forestry* has been a leading force in shaping public opinion favorable to forest conservation. Forestry commissioners were appointed in various states in rapid succession, and state and local forestry associations were formed.

All of the above forces working together so shaped public opinion that it became possible to enact legislation in 1891 making the public ownership of forests possible. Prior to this date New York and a few other states had begun the establishment of state and communal forests, but purely for the purpose of protection, recreation and sport. Up to this time forest conservation in the United States was not in the woods. It was chiefly educational propaganda—the shaping of public opinion in the desire for forest conservation. National forests were established in rapid succession after the above date. Many states began or continued the policy of acquiring forest property for state forests; and later, here and there throughout the country, but particularly in the east, counties, cities and towns began to acquire adjacent lands for communal forests.

The establishment of public forests has gone on until at the present time approximately one fifth of the forests in the United States are public forests, to be held for the production of timber and for protective purposes. During the long period of propaganda leading to the approval of, and the desire for, the public ownership of forest property in the United States, the burden of developing public opinion favorable to forest conservation fell upon the shoulders of a small number of men who were willing to contribute their time and money toward what they believed to be a great and pressing public need. As time passed, this small group grew into a vast army and public opinion favorable to forestry was the inevitable result. It is the writer's belief that no republic can reach even the beginning of forest conservation unless some of her citizens recognize the need and are willing to sacrifice their time and money for this public necessity.

I purposely place great emphasis upon the period of educational propaganda because without it our remarkable development in forestry during the past twenty-four years would have been impossible. *A great constructive movement in forestry can not be initiated in a republic without the people solidly behind it.* Our constructive work of the past two and a half decades rests upon years of organized edu-

cational prapaganda. Our sister republics in their efforts to place forestry upon a sound foundation must build the foundation out of public desire. Organized educational propaganda in the hands of national and local forestry associations, propagandist journals, and efficient press bureaus are the great forces in creating a public opinion favorable to forest conservation. When public desire has been created the practise of forestry becomes possible. It is not possible earlier.

Although educational propaganda favorable to forestry began in the United States more than a century ago, technical training in the science and art of forestry had its beginnings within the past two decades. The first forest school of collegiate rank was established at Cornell University in 1898. Two years later a professional forest school was established at Yale University. During the following decade and a half more than twenty schools or departments of forestry offering professional training and a degree in forestry after the completion of a prescribed course were established in various parts of the country, either as separate institutions or as departments of existing universities and colleges.

The question naturally arises, Why was technical training in forestry so long delayed and why has it met with such extraordinary expansion in the short space of seventeen years? The answer is found in the bringing of approximately 20 per cent. of all the forests of the United States under public ownership.

The establishment of public forests carried with it the necessity for their management and orderly development. This could not be attained without men trained in the science and art of forestry. The segregation of 162 national forests from the unoccupied public domain having an average area of more than 1,000,000 acres, within the space of twenty years has in itself called for the services of hundreds of technically trained men, and will call for many more men with the gradual increase in the intensity of management. The schools arose to supply this demand for trained men. There was no demand for professional schools until public ownership of forest property became the keystone in our forest policy, and there would be but little demand now were this keystone removed. Our whole structure of forest conservation, of forestry education, of forest practise rests upon the public ownership of forests. The economic situation relating to private forest property is such that, in the main, exploitation rather than forestry will be the basis for operation for many years to come. Pull down the keystone of public ownership and the splendid structure that has been erected with its great National Forest Service and the forest service of the several states will crumble, cobwebs will cover the windows of our professional forest schools, and the dark ages of forestry conservation will again prevail. The keystone must not be removed. It is believed that public opinion will not waver from the task that it has set, but will strengthen as time goes on *until at least 50 per cent. of the strictly non-agricultural lands capable of producing forest crops is publicly owned,* until at least this amount of our potential forests are back in the hands of the public who made the great economic mistake years ago in bartering them for a mess of pottage. If this optimistic view of forestry in the United States prevails, the efficiency and power of our forest schools will increase and they will gradually adjust themselves more closely than at present to the needs of the country.

The remarkable increase in agricultural research and education in the United States during the past half century has pro-

foundly influenced agricultural production. The vast sums spent annually by the nation, the states and lesser governmental units are returned a hundredfold by increased and diversified production. Our large number of agricultural colleges and experiment stations are living monuments to the public belief that the conservation of agriculture squarely rests upon the educational forces that direct and shape its progress. Our forest schools and research stations are just as essential in our scheme of education if the practise of forestry becomes a part of our national development and the future growth of forest crops adequate for our needs.

The superior position of Germany in forest conservation, whereby she produces nearly all of her wood requirements without lessening her forest capital through overcutting, is due to her many, long-established forest academies and other institutions where hundreds of young men are trained in the production and utilization of forest crops and in the principles which underlie a sound and economic forest policy. Her technical forestry education has been of slow but progressive growth, beginning with the "master schools" of Zanther, Hartig and Cotta nearly a century and a half ago. Each of these forest managers surrounded himself with young men and taught them the principles of forest practise on the forests under his charge. This early work gradually grew into the present educational system with the many forest academies and other institutions for the training of men in the science and art of forestry. The gradual development of forestry education in Germany has resulted in a healthy growth and has moved in the direction most useful for the needs of the country. A similar development of forestry education in the United States was impossible, due to the establishment of more than 165,000,000 acres of public forests in less than two decades, all awaiting organization and orderly development and for which the public was willing to pay. Hundreds of trained men were wanted at once to assume responsible positions as district chiefs, inspectors, investigators and supervisors. This call for a large number of professionally trained men at one time has resulted *in a remarkable growth in forestry education in the United States.*

Forestry education in the old world has developed around two general types of schools, viz., the university schools and the better type of forest academies, which are strictly professional in their training, and the ranger or practise schools, which are vocational in training. The former are scientific, and the preparatory and technical courses are equivalent to five or six years of collegiate work in this country. The latter are primarily concerned with the recognized art of forestry in the particular region where the men are trained to practise. The course is usually but one or two years in duration and is based upon a common school education. The men trained in the first of these two classes of schools after a year or more of apprenticeship under a practising forester are in line for gradual promotions to the highest positions which the profession has to offer. The men trained in the second are equipped for the vocation of ranger, woods foreman, and similar positions concerned with the oversight of labor in producing and harvesting the forest. The purpose of the latter school is entirely different from that of the former. Its aim is to train men for subordinate positions.

In the organization and orderly development of forest property there is need for many more men trained in the vocational schools than there is for men trained in the

professional schools. In forestry, scores of foremen, guards and rangers are necessary for every professionally trained forester. Where one man trained in the science of forestry will find a position suitable to his attainments, many men vocationally trained in the local art will find work.

A hard and fast line can not be drawn in this country between these two classes of schools, although, in the main, there has been an abnormal development of the professional schools and an underdevelopment of the vocational schools. The reason for this one-sided development of forestry education in the United States is found in the demand for professionally trained men in the decade between 1902 and 1912, which is the period during which nearly all the professional schools were established. The transfer of the national forests to the Department of Agriculture in 1904 and their organization under the Forest Service created positions for a large number of trained men. During the same period a rapidly increasing demand for professionally trained foresters was created through the establishment of departments of forestry in many states. All of these positions, with the possibility of rapid promotion, were highly attractive to college men. How rapidly the educational machinery of the country responded to this demand for technical training is shown in the number of schools now offering degrees in forestry and the facilities for technical training that are in the process of development.

The following is a list of the institutions in the United States that offer technical courses in forestry leading to a collegiate degree. This list shows the number of degrees granted by each institution prior to December, 1915, and the number of graduates actually employed in the profession in April of the same year.

Institution	No. of degrees granted prior to Dec., 1915	No. of graduates engaged in forestry, Apr., 1915
Colorado College School of Forestry	10 F.E.	
Colorado Agricultural College	1 M.F.	8
Cornell University	4 B.S.F 17 F.E. 16 B.S.F. 11 M.F.	3 35
University of California	0	
Georgia State College of Agriculture	3 B.S.F.	—
Harvard University	53 M.F.	50
University of Idaho	8 B.S.F. 1 M.F.	 5
Iowa State College	37 B.S.F.	25
University of Maine	50 B.S.F.	30
Michigan Agricultural College	97 B.S.F.	48
University of Michigan	103 M.S.F.	71
University of Minnesota	83 B.S.F. 1 M.S.	 63
University of Missouri	6 B.S.F.	2
University of Montana	1 B.S.	—
University of Nebraska	60 B.S.F. 1 M.F.	 46
Ohio State University	80 B.S.F.	47
Oregon Agricultural College	28 B.S.F.	16
Pennsylvania State College	106 B.S.F.	68
Syracuse University	31 B.S.F. 4 M.F.	 11
State College of Washington	2 B.S.F.	—
University of Washington	23 B.S.F. 8 M.S.F.	 22
Yale University	340 M.F.	253
Totals	1,185	803

In the space of fifteen years 1,185 men have been granted degrees in forestry in the United States. About one half of the degrees granted have been undergraduate degrees given for four years of collegiate work. Advanced degrees in forestry are offered by ten institutions. These schools have large faculties of more mature and experienced instructors and are better equipped for instruction in both the science and art of forestry.

In April, 1915, out of 1,037 men who had then received degrees, 803 were reported as actually engaged in forestry. The tremendous influence of the United States Forest Service in shaping forestry education in this country is shown in the fact that from 1899 to 1915 there were 591 forest assistants appointed to that service

through civil service examinations, as shown in the table below. Of this number 273 were appointed through competitive examinations from among the graduates of a single professional school. The position of forest assistant is the lowest technical position in the service and new appointments to this position are determined by civil service examinations.

FOREST ASSISTANTS APPOINTED IN THE U. S. FOREST SERVICE FOR THE PERIOD BETWEEN 1899 AND 1915 INCLUSIVE

1899	2	1908	52
1900	2	1909	48
1901	8	1910	73
1902	13	1911	72
1903	19	1912	72
1904	42	1913	31
1905	57	1914	26
1906	35	1915	9
1907	30		
		Total	591

The universities and colleges in the United States that offer professional training in forestry granted degrees to 147 men in June, 1915. From the number of men now attending courses in forestry in these institutions it appears that a larger number will complete their training in 1916 and a still larger number in 1917. Four years ago 72 forest assistants entered the National Forest Service under civil service appointments. Since then the number of appointments has decreased with startling rapidity. Only 9 appointments to the position of forest assistant through civil service examinations were made in 1915. From 1900 to 1910 the number of yearly appointments increased from 2 to 73. It was during this period that the many schools arose and secured equipment and faculties to supply this rapidly increasing demand for professionally trained men. Although the schools are far better equipped than formerly, the rapidly decreasing demand in the public service, due primarily to the completion of the preliminary organization of the public forests, is forcing nearly all of the graduates in forestry during 1915 to seek employment in the forests under private ownership or to find places on the public forests that are also open to those without a professional training, hoping to be promoted to better positions later on. From now onward, the annual appointment of technically trained men to new positions in forestry under the national, state and lesser governmental units depends upon the rapidity with which additional public forests are established and the subdivision of present public forests into smaller and more intensively managed units. *We can not expect in the future a demand in public forestry for men with a professional training at all commensurate with the increasing supply of such men.*

Trained foresters must be willing immediately after graduation to do the work of ordinary labor and work for the same wages as ordinary labor. They must look upon this period of their life as a period of apprenticeship. Accepting this point of view, the whole question of its desirability rests with the probability of promotion after a reasonable apprentice period has passed. In the main, it must be considered a mistake for a man who has spent from four to six years in collegiate and professional training to accept a position either in governmental or private work unless it leads towards a field that will enable him to practise his profession at a remuneration somewhat proportionate to his technical ability.

The permanent labor employed in our public forests, including the position of guards and rangers, is usually recruited from among residents of the states where the forests are located and from men wholly without technical training, but with a more or less intimate knowledge of local conditions. The examination required is not technical in character. These men are

employed in large numbers and at first are, without doubt, more useful than professionally trained men unfamiliar with the locality and conditions when employed at what is ordinarily considered guard or ranger work. From amongst this army of men without professional training, many are later promoted to the position of supervisor and to other places in the higher branches of the service. These promotions are made without further examinations. There is no doubt but that qualities that lie wholly outside of technical efficiency are of fundamental importance in the appointment to the lower places in public forestry and in later promotion. When these other qualities are acceptable, however, appointment and promotion should center upon thorough technical preparation, upon an intimate knowledge of the science of forestry which can seldom be obtained except by a series of years of systematic training. Rule-of-thumb methods picked up in the woods seldom prepare a man for justifiable promotion to positions that deal with the organization and orderly development of forest property. Were this fundamental distinction between technical training and woods experience adequately appreciated in promotion, the college man with technical training could better afford at the outset of his professional career to take his place with ax and saw by the side of his non-technical competitor.

The largest present field for men immediately after completing their professional training is in private work, but here a man must prove his worth before he is given more than a workman's wage. Although four fifths of our forests are privately owned, the economic conditions that control timber prices are such that professionally trained men can rarely be employed under adequate salary, and money can seldom be expended by private owners for the sole purpose of employing scientific methods in the production of forest crops. When employed, their work must deal with methods of better and closer utilization rather than forest production. Although this field is unlimited for professionally trained men who are willing to begin at the bottom and offers the highest financial prizes for those having the requisite qualifications, *the qualifications based upon full professional training are secondary to other more fundamental ones which combined form business efficiency and business sense.* It is bad foresight to train so many men in the scientific production of forest crops that the larger proportion are later forced into farming or various commercial callings.

Although full professional training is essential in national, state and communal forestry where present expenditures are possible through public appropriations for the organization and orderly development of the forest, I seriously question whether at present it can find adequate scope in private forestry, *because the organization and orderly development of the privately owned forest can seldom be attempted under present economic conditions.* What private forestry in the United States needs is more vocational training and less professional training. A few instead of many strong professional schools, well equipped for both teaching and research, whose graduates can find adequate scope for their attainments, *should rest upon a much broader foundation of public and vocational training in forestry* than we have at the present time. It is the duty of these schools to lead in forestry investigation, the publication of technical books on forestry, and the support of technical journals.

Agriculture and forestry have close kinship. They both have to do with the production, harvesting and marketing of crops grown from the soil. They differ

chiefly in the time required for the crop to mature. Why should we not have state, county and town institutes that impart public instruction in forestry as well as in agriculture? Why should we not have instruction in forestry in certain high schools and other institutions as we now have in agriculture? Why should we not have field demonstrations for the public in forestry as well as in agriculture? Not only have we, in our heroic efforts to erect many professional forest schools, been *negligent in supplying the educational machinery for educating the public in the scientific treatment of woodlands, but we have been equally negligent in supplying the machinery for vocational training.* Although more than fifty institutions in the United States have within the past fifteen years developed more or less work in forestry education below the grade of full professional training, it has largely been without definite aim and has been poorly suited to the real needs of the country. Very little of it even approaches the requirements of the ideal vocational school. As reported by the committee on forestry education at the Fifth National Conservation Congress:

> The vocational forest school should bear the same relation to professional training that the woodshop bears to research in technology or the business school to university instruction in economics and commerce. It is analogous to the trade schools or a system of apprentice training whereby men are equipped for the skilled trades. The vocational school must, therefore, aim to teach the art or trade of forest practise, not the science of forestry.

In order best to serve the purposes of forestry education in the United States at least two thirds of the money now expended on professional training could be better spent in the instruction of the public through the organization of institutes, field demonstrations and similar methods that have been found so effective in agriculture, and in the organization of vocational schools for the training of young men in the art of forestry practise.

What does the experience of the United States in forest conservation and in the development of forestry education teach that can be useful to her sister republics? The writer believes that it teaches the following fundamental truths:

1. *The possibility of forest conservation in any republic which has for its foundation the orderly development of forest property and a sustained yield rests squarely upon organized propaganda which has for its purpose the creation of public opinion favorable to forestry*—a public opinion that is willing to make present expenditures for future welfare.

2. *The keystone in organized propaganda must be centralized in public ownership, i. e.,* absolute forest lands must, so far as present economic conditions permit, be owned by the public and managed by and for the public.

3. *Organized propaganda must continue as an indispensable part of forestry education,* even after the beginning of forest conservation has been effected through public ownership. A strong public sentiment favorable to forest conservation is the only effective weapon for keeping public forests from exploitation by those who consider public property their just prey and await every opportunity to pounce upon it.

4. *Forestry education beyond that attainable by organized propaganda for the purpose of molding public opinion should result in putting the actual practise of forestry into operation upon both public and private forests to the fullest degree consistent with economic conditions.* It can attain this end only by welding together and giving emphasis to each of the following: (*a*) Forestry education when the training is secondary to other work. (*b*)

Vocational training in forestry. (*c*) Professional training in forestry.

The overstimulation of professional training whereby a much larger number of men of high educational attainments and thorough technical preparation are trained than are able to find professional employment is a waste and detrimental to forest conservation. On the other hand, secondary and vocational training can scarcely be overstimulated. It is the writer's opinion that the progress made in the actual conduct of forestry operations in the woods must center in a vast army with some training rather than full professional training, whose knowledge of forestry is chiefly confined to the art of forestry so far as it concerns their own locality and who do not look for, and should not expect, a wage beyond that which the operations justify.

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ON CERTAIN RELATIONS OF THE LOWER ANIMALS TO HUMAN DISEASE[1]

ONE of the striking tendencies in modern medicine has been an increasing apprecia-

[1] Read at the Quarter-Centennial of the University of Chicago, Departmental Conference in Pathology, June 6, 1916.

tion of the importance of the lower animals in relation to human disease. The subject is a vast one and may be discussed from many standpoints. Medically, animals may serve humanity or they may be directly responsible for terrible scourges. For experimental and teaching purposes in all departments of medicine they are indispensable and this forms one great field of usefulness for them. A second field is their use in the production of curative substances—serums, vaccines, ductless gland preparations, drugs, etc., a field which marks an epoch in modern medicine.

The relation of the lower animals to the transmission and causation of disease is another phase of this subject, but here the results, unlike those in the two fields above noted, are almost invariably serious for the welfare of man. In this field many great and interesting discoveries in recent years have been made. I shall limit myself to this topic and shall try to point out some of the more noteworthy features in this relationship and their bearing on preventive medicine.

Historically, in the very earliest accounts of primitive people, there are records concerning the relation of animals and animal parasites to the causation of disease. In Hirsch's classical work on geographical pathology we find a discussion of the records of the "fiery serpents" (probably the guinea-worms) that afflicted the Hebrews in their wanderings in the desert; and Plutarch narrates that "the dwellers by the Red Sea suffer from a serious malady due to a small serpent which issues from the skin to gnaw the arms and legs and retires underneath the skin if disturbed, causing the patient intolerable pain." Intestinal worms especially were well known to the ancients and form an important chapter in their medicine. In primitive peoples bites and lacerations by wild animals and snakes with the resulting secondary infections following such wounds gave rise to disease. Rabies was known over 2,000 years ago. It is of such a nature that its relation to dogs and other animals could easily be traced and this connection was well appreciated by the medical authorities in those times. Varro (116–27 B.C.) suggested that malarial fevers were transmitted by insects.

A landmark in the relationship of animal and human disease was the observations of Jenner in 1796 on the relation of smallpox and cowpox. The story is well known and need not be related here. It is a splendid example of careful observation, experiment and practical application even for our own day. Many of our most important modern problems—infection, immunity, prophylaxis, anaphylaxis, vaccination—have their beginnings here.

Coming now to the bacteriological era inaugurated by Pasteur during the latter part of the last century we note that the connection and interdependence between many animal and human diseases, though recognized before, became ever clearer and more definite. The work of Pasteur on animal diseases, especially anthrax and rabies, of Villemin on tuberculosis, of Koch on anthrax and tuberculosis, of Loeffler on glanders, of Bollenger on actinomycosis, may be mentioned in this connection. This was the era of great and numerous discoveries and the principles then established have directed and stimulated bacteriologic work to the present day.

Shortly after the advent of the bacteriological era there was superimposed upon this another era, that of protozoology. This may with propriety date from the discovery by Theobald Smith in 1889 of the causal organism (*Piroplasma bovis*) of Texas fever in cattle. A little later Smith and Kilbourne determined that the mode of transmission in this disease was by the cattle tick. The fact should be noted however that many years before, in 1864, Pas-

teur showed that the famous epidemic of silkworm disease in France was caused by a protozoan (*Glugea bombysis*) and this might be considered the first great discovery in this field. Another early discovery in protozoology was that of the malarial parasite by Laveran in 1880. These years, however, were so thoroughly dominated by bacteriologic conceptions that Laveran, thinking that the parasite belonged to the plant kingdom, gave it the name "oscillaria."

The significance of Smith and Kilbourne's discovery and what really marked a new epoch in the study of disease was the principle involved in the mode of transmission of an organism through infected ticks (and only in this manner) and in the fact that a definite series of changes necessary for the propagation of the disease went on in the body of the tick by the infecting agent. Here was an observation that opened a new field in the relation of animals to human disease and upon this basis the great discoveries in connection with the transmission of malaria, yellow fever and many other diseases, especially tropical, were later made. The mode of transmission in such diseases having thus become known their control in many instances has become a relatively simple matter.

To convey an impression of the importance and of the large number of diseases of man carried by the lower animals and as an introduction to a discussion of the varied relations of animals to human disease I will present the following résumé:

HUMAN DISEASES CARRIED

1. By the dog:
    - Rabies.
    - Foot and mouth disease.
    - Helminthiasis.
        - Flukes.
        - Tapeworms (especially *Tænia echinococcus*).
    - Infantile splenomegaly (from dogs through fleas).
    - Trypanosomiasis (*T. gambiense*).
    - Mange.
    - Fleas and ticks.
    - Ringworm.
    - Favus.
2. By the cow:
    - Tuberculosis.
    - Actinomycosis.
    - Anthrax.
    - Cowpox.
    - Tetanus (through vaccine).
    - Foot and mouth disease.
    - Septic sore throat.
    - Rabies.
    - Pus infections.
    - Tenia saginata.
    - Milk sickness.
    - Paratyphoid fever.
3. By the horse:
    - Glanders.
    - Rabies.
    - Tetanus.
    - Sporotrichosis.
    - Anaphylaxis.
        - Serum disease.
        - Odor of horses.
4. By swine:
    - Trichiniasis.
    - Tuberculosis.
    - Anthrax.
    - Cestodes (especially *T. solium*).
    - Trematodes.
5. By sheep:
    - Anthrax.
    - Tuberculosis.
6. By goats:
    - Malta fever.
    - Tuberculosis.
7. By the antelope:
    - Sleeping sickness.
8. By the cat:
    - Rabies.
    - Cestodes.
    - Trematodes.
    - Favus.
    - Ringworm.
9. By rats:
    - Rat bite fever.
    - Bubonic plague (through fleas).
    - Trichiniasis (through hog to man).
10. By ground squirrels:
    - Bubonic plague.
11. By birds:
    - Psittacosis (from parrot).
12. By fish:
    - Tape worms.
13. By arthropods, chiefly insects:
    - Mosquitoes:
        - Yellow fever.
        - Malaria fever.
        - Dengue fever.
        - Filariasis.
    - Fleas:
        - Bubonic plague.
        - Infantile splenomegaly.
    - Ticks and mites:
        - Rocky Mountain fever.
        - Relapsing fever (African).
        - Tick fever of Miana.
        - Japanese flood fever.
    - Lice:
        - Typhus fever.

Relapsing fever (*Spirochæta obermeieri*).
Bed bugs:
Kala azar.
Flies:
Sandfly fever.
Sleeping sickness (tse-tse fly).
Typhoid fever and other infections carried mechanically.
Crustaceans (water flea):
Guinea worm infection (dracunculosis).
Oysters, clams, etc.:
Typhoid fever.
Snails:
Trematode infections (especially bilharziosis).

In this outline I have included the most important human diseases that in one way or another are wholly or to some extent dependent on lower animals for their existence and transmission. As given the list is not entirely complete, and if it were complete to-day it might not be complete tomorrow, so rapidly are discoveries especially in tropical diseases being made. The rôle that lower animals play in the transmission of intestinal parasites, for example, is exceedingly varied and though a prodigious number of these parasites have been described and their hosts and intermediate hosts determined there are still very many about which little or nothing is known. In the outline as given I have mentioned only some of the more important examples in this great group.

I wish now to briefly analyze some of the relations of the lower animals to human disease transmission. We find these relations in certain instances to be very simple, in other instances extremely varied and complex. The direct portals of entry into man are usually through the skin, the respiratory and the gastro-intestinal tracts. In some diseases transmission can occur in only one way. In others the transmission may take place in a great variety of ways. I will first group and summarize the modes of transmission as follows:

I. Infection in man may occur through simple contact with diseased animals. Excretions from lesions of skin, nose, lungs and intestines are the usual vehicles. As examples we may cite glanders, anthrax and cowpox. Previous wounds of the body surface may or in some cases may not be necessary for the transmission. The virus also may enter the body through the respiratory or gastro-intestinal tracts. While often this method of transmission is simple and direct, at times the virus may be carried long distances in very indirect and circuitous routes from the animal to man. This is particularly true of the spore-bearing organisms. Recently an outbreak of several cases of anthrax occurred in England which after considerable difficulty was traced to the use of infected shaving brushes. The anthrax bacilli were recovered from the used brushes as well as from new brushes from the same stock obtained in a store. They were made with hair from a diseased animal.

II. The infectious agent may be carried mechanically from person to person or from animal to person through food or otherwise by a second animal; as in the transmission of typhoid, dysentery, cholera, etc., by flies. Foot and mouth disease is said to be carried over long distances by dogs. Oysters thus transmit typhoid.

III. The animal may through a bite produce a lesion into which the infectious agent is transferred, as in rabies and especially in the blood-sucking insect diseases. Rat-bite fever, which according to the recent work of Hektoen and Tunnicliffe may be caused by the streptothrix of rat pneumonia entering the wound caused by the bite of the infected rat, would be here included.

IV. The parasite may be transmitted to man through the meat of lower animals used as food. It is possible though rare for certain bacterial diseases like tuberculosis and perhaps paratyphoid fever to be

transferred to man from the cow in this way. Tapeworm infections of various kinds are thus transmitted from a number of lower animals.

V. The infectious agent may be transmitted to man through the secretions of the lower animals. Here are included some of the most important and serious of human diseases. Malta fever is transmitted largely in this way through the milk and urine of goats infected with *Micrococcus melitensis*. The malarial parasite is transmitted to man by the anopheles mosquito through its salivary gland. Tuberculosis especially in children is often transmitted from the infected cow through the milk. In this connection the epidemics of streptococcus sore throat are interesting. Over thirty milk-borne epidemics of this infection have been reported and from the recent work of several investigators it would seem that in some instances virulent streptococci of the human type may find their way into the udder of the cow through the contaminated hands of the milker and there multiply and return subsequently in large numbers in the milk and infect the consumer. Some of these epidemics and perhaps many of them have originated thus. Capps and the writer several years ago and more recently Mathers have shown experimentally that virulent human streptococci when placed on the abraded teat of a cow will ascend the canal and infect the udder; or when injected directly into the udder will continue to multiply there, causing a mild or even a severe mastitis lasting for several weeks or for months. The streptococci in large numbers will pass out in the milk during this period and will retain their initial virulence for animals. Other kinds of infections may be transmitted in this way though perhaps rarely. True diphtheria bacilli, for example, have been isolated by Dean and Todd from the ulcerated teats and from the udder of a cow supplying families in which a diphtheria outbreak occurred.

Milk is such an universal food for both men and bacteria that it has been the vehicle for the transmission of many of the infectious diseases. In the outline given I have not mentioned the diseases which may be transmitted through milk, the virus having entered the milk after leaving the cow. In such infections the animal is not concerned directly in the transmission but only indirectly through its product.

VI. The infectious agent may enter one of the lower animals in which it passes through a regular phase or completes a cycle and then, usually through a bite of the animal, is transmitted to man. This mode of transmission concerns many of the protozoan diseases. We may group such infections under two heads: (*a*) those transmitted from man to man by a lower form, examples of which are the malarial parasite in the anopheles mosquito and the yellow fever virus in the stegomyia mosquito; and (*b*) those transmitted from an animal to man by one or more of the lower forms, illustrated by the transmission of *Trypanosoma gambiense* from the antelope or from the dog or the monkey to man through the tse-tse fly. In this case one or more of the lower animals are concerned in the transmission of a second animal, the parasite, to a third animal, man. Both (*a*) and (*b*) may occur in the same disease. The principle of host and intermediate host here involved is a very important one and numerous examples might be given. Many of the intestinal parasites, the entozoa, pass a part of their cycle of development in a lower animal. Most interesting relationships exist in this connection between some of the nematoda and the trematoda or fluke infections in man and certain small water animals, including crabs, snails and other arthropods. For example the guinea-worm,

a filarial parasite in man, lives in the tissues and at times the female bores outward through the epidermis, discharging the embryos which, if they find water, swim about and enter a small crustacean, the waterflea or cyclops, in which they remain for several weeks undergoing certain transformations. Finally they may enter the stomach of man through drinking water and then bore through the stomach wall into the tissues again. The liver fluke, common in sheep causing the disease "sheep rot" and occasionally found in man, uses several varieties of snails as hosts passing through certain rather complex changes and later leaving the snail to become encysted on grass or weeds which are eaten by sheep.

Through the recent work in Egypt of Colonel Leiper and his associates in the Royal Army Medical Corps it seems now to be firmly established, contrary to the views of Looss, that the fluke, *Schistosoma hæmatobium,* the cause of bilharziosis, after leaving the body in the urine uses the snail as an intermediate host in which it undergoes a metamorphosis before it is capable of infecting another person. Infection with the fluke actually takes place both by mouth and through the skin of the individual. It has been shown that eradication of this very prevalent and serious disease in the Orient will depend upon the destruction of snails, the cooperation of the infected individual not being necessary.

This résumé in a general way I think includes the modes of transmission of at least most of the human-animal diseases as we at present know them.

I wish now to call attention to a number of points which are frequently of great importance in the control of many of these diseases. For convenience of presentation I will mention them under four heads:

1. A lower animal may be the only agency in the spread of a disease. In malaria the available evidence indicates that the disease is spread only by the anopheles mosquito, although several varieties of this species harbor the parasite. So also yellow fever is spread, so far as we now know, only by the stegomyia mosquito.

2. Several different species of lower animals may be concerned in the transmission of the disease. As examples we may cite rabies which is transmitted by dogs, cats, wolves, horses and other animals; anthrax by sheep, cows, etc.; bubonic plague by rats and ground squirrels. The question as to whether a given disease is transmitted by one animal only or by several is so important so far as control measures are concerned that I need only pause to mention it.

3. The lower animal may be a "healthy" carrier. That is, the infectious agent though perhaps highly virulent to man may not cause the animal to become sick. A striking example of this condition is the Malta fever infection (*M. melitensis*) in goats. Malta fever, a human disease very common in Mediterranean countries and now prevalent in our southwest, is spread through the milk of goats. In most of these animals there are no symptoms whatever, the micrococcus being found in the milk or urine or blood of animals perfectly healthy and which remain so. Typhoid bacilli may live in the intestinal canal of flies. Tetanus bacilli may live for months in large numbers in the intestinal canal of horses, certain of these animals becoming virtually tetanus "carriers."

4. The lower animal may be a diseased "carrier"; that is, the infectious agent may cause the lower animal to become sick. Glanders in horses, rabies in dogs, anthrax in sheep are examples. This matter of degree of reaction or the severity of the disease in the animal is of very great importance in the control of the disease. From the standpoint of man's welfare it is often highly advantageous that the infection in

the animal should not only show symptoms but should be rapidly fatal so as to remove the source of danger as soon as possible. Malta fever is a very different disease to control because the goats so often show no clinical symptoms. Also a chronic disease in animals is a source of danger for a long period of time whereas the acutely fatal diseases terminate the danger quickly. Chronic glanders in the horse as compared with acute glanders illustrates well this point. Furthermore by the death of the animal in the rapidly fatal diseases usually the more highly virulent and hence the more dangerous strains of microbes are destroyed at the same time.

Usually the natural animal diseases transmissible to man are deleterious to him. Occasionally a natural animal disease has been made to serve a good purpose by furnishing a means for protective inoculation in man. Cowpox is an example, the natural virus being continued in the cow and then transferred artificially to man for protective purposes against smallpox. The Pasteur treatment in hydrophobia depends on much the same principle, the virus being propagated however in another animal, the rabbit, the spinal cord of which is then artificially inoculated into man for preventive purposes.

As a result of the use of animal products for protective and curative purposes in medicine, there is produced at times the condition of anaphylaxis known as "serum disease." This reaction is so serious that it may actually interfere with the use of serums over long periods of time in the treatment of chronic disease. The success of serum therapy has so far been confined largely to acute diseases which ordinarily do not require long treatment, so that the danger of anaphylactic shock has not in this respect seriously restricted the use of serums. In this connection might be mentioned the state of certain individuals who are hypersensitive perhaps naturally to the odor of horses and when near the animal manifest definite symptoms of an anaphylactic character.

Certain diseases common in animals and man exist in which there is little or no evidence that man is infected directly from the animal. Actinomycosis is such a disease. It is doubtful if there is a case on record in which man became directly infected with the actinomyces through contact with a diseased animal. Sporotrichosis likewise is common in horses and in man, but there is but one or two cases where direct infection occurred and this was through the bite of a horse. In such diseases the animals are dangerous not so much through direct contact as through the general dissemination of the microbes upon soil, grass, fodder and various objects, thereby greatly increasing the opportunity for human infection in a variety of indirect ways.

While man receives a large number of diseases from or through the lower animals, if we inquire into the reverse proposition, we find that any one of the lower animals though suffering on the whole from many diseases, acquire relatively few from other animals including man. The horse, for example, receives rabies from dogs, and occasionally anthrax from sheep and cows. Tuberculosis hardly exists in this animal. In the tropics it has its diseases carried by flies and ticks though they apparently are not as numerous as the human diseases so transmitted. The cow appears to be somewhat more susceptible to diseases from other species than is the horse but apparently not as susceptible as man to such. The dog and the other animals enumerated, all have a host of their own diseases, relatively few of which seem to depend on some other animal for their transmission. Exception might be taken to this statement concerning the lower animals. It may be that it

only appears to be true because we know more about the diseases of man than those of the lower animals.

Certain reasons may be here enumerated why man is subject to at least many of the animal diseases. Man is commonly concerned in caring for sick animals and some diseases, like glanders, are commonly transmitted in this way to veterinarians, hostlers and teamsters. The demand of the human for animal pets and the social demands of certain types of humanity for dogs, cats and other animals living in intimate association with them explains the origin of certain diseases, especially those parasitic in character. Man lives largely on meat and other animal products, many of which are uncooked or improperly cooked. Man uses animals in a variety of ways in the industries, the relations being often such as to necessitate intimate contact. Again, wild animals are free from many diseases but domestication or confinement by man may make them highly susceptible. Such animals then may become a source of danger to man and thus a vicious circle is established.

The transfer of certain diseases from animals to man is, under existing conditions, not a reversible process. Rabies is commonly transmitted from dog to man but practically never, so far as we know, in the reverse direction. This is true of many diseases and depends upon such factors as the superior care given to the human sick and the methods of isolation.

It would seem then that man's relations and points of contact with a large variety of the lower animals are more intimate and complex than those of any of the other animals to other species and as a result of such relations, on the whole, the disease transmission from animals to the human is naturally increased in number and variety. This is one of the penalties that man pays for being nurse, doctor and master of the brute creation.

While animals play such a very important rôle in the transmission of disease to man it is interesting to note that plants play practically no rôle whatsoever in this regard. Though plants are afflicted with microbic and fungous diseases to an extent probably even greater than are animals, only one organism is known which is apparently pathogenic for both plants and man. According to the work of Johnston,[2] cocoanut budrot, a disease of the cocoanut common in Cuba, is caused by an organism practically identical with *Bacillus coli* (Escherich) Migula. Inoculations into cocoanut seedlings with *B. coli* of animal origin give infections similar to inoculations with the cocoanut organism. It may be stated, however, that this plant disease is of no significance, so far as we know, in the transmission or the causation of human disease, since *B. coli* ordinarily does no harm when taken into the alimentary canal. It is true, of course, that many plants carry disease germs such as typhoid and dysentery bacilli mechanically upon their surface where they may remain alive for some time and in this respect play a rôle comparable to that of flies in the transmission of typhoid fever.

The higher plants being so remote biologically from the higher animals it is improbable that specific disease germs pathogenic to these two types of organisms will be found. However it is possible that plants may be found which serve as intermediate hosts for organisms not pathogenic for them but pathogenic for certain animals. Many of the viruses and parasites which cause disease in man use some lower form of animal biologically far removed from man for a certain period of their de-

[2] "The History and Cause of the Cocoanut Budrot," Bull. No. 228, Bureau of Plant Industry, 1912.

velopment, but do not cause symptoms in this animal. The malarial parasite and the yellow fever virus do not seem to injure the mosquito. Nor does the virus of Rocky Mountain fever injure the tick or that of typhus fever the louse. There is, as we know, some degree of parallelism between biological relationship and susceptibility to a given virus. But this susceptibility has nothing to do necessarily with the ability of an animal to serve as an intermediate host or to harbor a parasite.

The question of adaptation in this connection should be mentioned. It is a problem which for a long time has interested the bacteriologist, but by none has its importance been more clearly grasped than by Pasteur who was influenced so decidedly in his experimental work on animals by this principle. In the relation of disease to animals most of the important points center around this fundamental idea in one form or another. It goes hand in hand with the principle of specificity. A given organism supposedly specific for a given animal may acquire the property by adaptation of growing in the body of another animal. It has widened its sphere of activity in certain respects but in other respects it is as specific as ever. Specificity like immunity is a phase of the principle of adaptation. In the study of human-animal disease we note that some organisms naturally are adapted to grow in a variety of animals, others limited very decidedly to a particular animal and even to a particular race of a given species. By experiment these latter may be made to widen their sphere of activity very appreciably. As specific illustrations I may cite the early contributions of Welch and the recent work of Gay and Claypole in causing the typhoid carrier state in rabbits; also the work of Culver in increasing by repeated transfers the resistance of the gonococcus to rabbit serum and the infection of rabbits with such a strain. Some strains of bacteria identical when tested by our most refined laboratory methods may be highly pathogenic for a given animal but non-pathogenic for even a closely related species.

As to the importance of such processes of adaptation in nature for the dissemination of disease from one variety to another or from animal to man, it is very difficult to obtain, experimentally or otherwise, definite data extending over a sufficiently long period of time to be of value. We can at present perhaps conceive of no better hypothesis for the origin of infections and their continuance. Bacteria are very old, there being definite evidence, as shown by B. Regnault and by Moodie of the existence of bacilli and cocci in the intestinal canal of animals (coprolytes), in decomposing plant and animal remains and probably also as disease producers in the Mesozoic and Pleistocene era ten to twelve millions of years ago. Far less change were necessary in the bacteria to develop into the types of to-day than have occurred in animals since that time.

There are many infectious diseases whose modes of transmission are at present obscure which no doubt will be found to be carried by some lower animal form. As an example of such may be mentioned Rocky Mountain tick fever, in which suggestive evidence exists of a relation to some wild animal, possibly the gopher (spermophilis), as a tick-carrier. The work of Strong and his associates on the two South American diseases, verruga peruviana and oroya, would indicate that they are transmitted by some arthropod. This has not yet been demonstrated. The modes of transmission of many trematode and nematode infections have not yet been discovered, but from what is known of such diseases there can be little or no doubt that many are transmitted through another animal. Infantile paralysis has been transmitted ex-

perimentally from animal to animal by flies but it has not yet been shown that flies play a significant rôle in human transmission. As to the fly it is difficult to determine how important it is in the transmission of a number of infections.

While much suggestive evidence exists concerning the rôle of animals in carrying certain diseases whose origin is still obscure, on the other hand, there is in the literature much loose speculation as to the rôle animals play in many such diseases. Superstition and tradition enter at times to aid this speculation. The older literature contains many articles on the rôle of dogs, cats, and other domestic animals in the transmission of the various contagious diseases, especially diseases of children. Syphilis, measles, scarlet fever, smallpox, etc., have been thought to be transmitted by lice, bed bugs, flies and other bloodsucking insects. Occasional instances of such modes of transmission have perhaps occurred or are possibilities, but there have been much worthless discussion and speculation on these subjects.

In the solution of the various problems that arise in connection with prevention of human-animal diseases no one rule can be established for their control. In the first place each disease must be studied by itself and its natural history in detail should be known in order to intelligently cope with it. Upon personal hygiene and care in all matters concerning diet, clothes, housing conditions and our relations to animal life as well as upon close observance of sanitary rules will largely depend the solution of these problems.

As already stated nearly all of these diseases are easily preventable once the true natural history of the disease is known. The serious problem then is usually the education of the public. To illustrate, in hydrophobia prevention centers around the problem of the muzzling of dogs. This has been known for decades, yet the American people prefer to have 5,000 persons, mostly children, bitten each year and a hundred or more deaths, than to subject their dogs to the discomfort of a muzzle and to destroy the stray and worthless curs of the street. It should be said that this has been true in the past. Now the problem has become far more serious. In our western states rabies has spread during the past year to the coyotes, wolves and other wild animals which wander about biting domestic animals, especially stock, and even attacking persons, particularly school children. Our government has now spent large sums in an attempt to control the disease, but, once in wild animals, it is known to be very difficult to eradicate. Thus the matters stand at present with this human-animal disease. Such an experience should serve as an example, and many others might be given, in this matter of the importance of animals to human diseases and their control.

The study of comparative pathology, it would seem, should occupy a more prominent place in the curricula of our universities and medical schools than it has in the past. When we consider the fundamental character of the studies in this field of pathology—the work of Jenner, of Pasteur, of Koch, of Theobald Smith and especially of a great group of investigators in recent years on cancer and on tropical diseases in man and animals—the truth seems evident that in the study of disease and in its presentation to students such an important field should not be slighted. Our study of disease in medical and veterinary institutions should be at least as broad and as comparative as is the study of zoology or botany. In order to understand the natural history of many diseases comparative studies are absolutely necessary. It would undoubtedly be advantageous both from a humane as well as from a scientific

standpoint if our medical schools and hospitals, our veterinary hospitals and even our cat and dog hospitals and other places for the care of sick animals could all be concentrated in one institution for the broad study of disease. This indeed is now being attempted in certain institutions and no doubt will result in a broader conception of pathology.

David John Davis
University of Illinois,
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Chicago, Ill.

INVESTIGATIONS AT THE WOODS HOLE BIOLOGICAL STATION OF THE UNITED STATES BUREAU OF FISHERIES

The laboratory of the Woods Hole Biological Station of the United States Bureau of Fisheries opened for the season's operations on June 19, under the directorship of Dr. P. H. Mitchell of Brown University. The various investigators are: Dr. W. W. Browne, of the College of the City of New York, who is studying various phases of bacteriology of fishes including bacterial changes during cold storage and the occurrence of pollution bacteria in food fishes; Dr. I. A. Field, of Clark University, who is completing a comprehensive report on the biology and economic value of the sea mussel and is conducting investigations on its embryology; Dr. C. W. Hahn, of the New York City High School of Commerce, who is studying sporozoan parasites of fishes with especial reference to modes of infection; Dr. Edwin Linton, of Washington and Jefferson College, who is studying fish parasites and the food of certain fishes; Dr. Sergius Morgulis, formerly of the College of Physicians and Surgeons, who is continuing researches on the metabolism of fishes; and Dr. G. G. Scott, of the College of the City of New York, who is studying the oxygen requirements of various marine forms and the oxygen consumption of developing fish embryos. The scientific assistants are: Mr. A. E. Barnard, of Brown University, who is working with the director on the nutrition of oysters; Mr. R. L. Barney, of Brown University, who is aiding the director in the study of diatoms of green gill oysters and the life history of sporozoan parasites; Mr. F. R. Dieuaide, of the College of the City of New York, who is assisting Dr. Scott and is making a collection of Woods Hole marine flora; Mr. E. W. Fuller, of Amherst College, who is assisting Dr. Morgulis; and Mr. K. S. Rice, of Brown University, who is assisting the director in the study of the food supply of oysters.

The facilities of the laboratory have also been extended to the following table applicants: Dr. N. A. Cobb, of the Department of Agriculture, and the Misses Cobb and Mr. Alfred Steinberg, who are assisting Dr. Cobb in the study of the physiology of nematodes; Dr. S. A. MacCallum, of New York City, who is investigating fish parasites, especially the helminthes; Dr. Albert Mann, of the Department of Agriculture, who is studying the diatom flora of the Woods Hole region; Dr. A. M. Reese, of West Virginia University, who is investigating light reactions of *Diemyctylus;* Mr. A. C. Redfield, of Harvard University, who is studying the melanophores of lower vertebrates especially in relation to adrenal glands of fishes; Mrs. A. C. Redfield, who is studying respiration in lamellibranchs; Dr. F. P. Reagan, of Princeton University, who is studying the development of *Fundulus heteroclitus;* and Mr. C. C. Speidel, of Princeton University, who is sharing a table with Dr. Reagan, and is investigating the function of certain peculiar cells of the spinal cord of the skate. The facilities of the laboratory will also be granted, during September, to Dr. F. C. Weber and assistants, from the Bureau of Chemistry, for investigations concerning copepods as food for sardines. The laboratory closes on September 15.

P. H. Mitchell
Woods Hole, Mass.,
August 29, 1916

SCIENTIFIC NOTES AND NEWS

The American Astronomical Society met in the Sproul Observatory, Swarthmore College,

from August 30 to September 2, with Dr. E. C. Pickering in the chair.

DR. THOMAS H. MACBRIDE has been elected president emeritus of the State University of Iowa, on his retirement from the presidency which he accepted two and a half years ago. Dr. Macbride had been assistant professor and professor of botany in the university since 1878.

DR. L. H. BAEKELAND has been appointed to represent the American Chemical Society on the Natural Research Council being organized by a committee of the National Academy of Sciences.

THE Alvarenga prize this year in Brazil was awarded to G. Riedel, chief of the biologic chemistry service at the Hospicio Nacional and instructor at the university. His work described researches on the protective ferments, and a process for determining the specific ferments by superficial tension.

PROFESSOR CHARLES RICHET, of the University of Paris, has been awarded the state prize for poetry. The subject was "The Glory of Pasteur."

WE learn from *Nature* that Dr. A. Lauder, of the Edinburgh and East of Scotland College of Agriculture, has been elected honorary secretary of the Edinburgh and East of Scotland section of the Society of Chemical Industry, in succession to Dr. J. P. Longstaff, now general secretary of the society in London.

DR. HERBERT R. BROWN has resigned from the position of assistant director of the Massachusetts State Department of Health to accept an appointment as pathologist at the Rochester Homeopathic Hospital at Rochester, N. Y.

THE position of assistant botanist to the Missouri Botanical Garden has been filled by the appointment of Mr. J. C. Th. Uphof, for the past three years assistant professor of botany at the University of Arizona.

ON the initiative of the Royal Society a Board of Scientific Societies has been established in Great Britain to promote the cooperation of those interested in pure or applied science; to supply a means by which the scientific opinion of the country may, on matters relating to science, industry and education find effective expression; to take such action as may be necessary to promote the application of science to industries and to the service of the nation; and to discuss scientific questions in which international cooperation seems advisable. The board at present consists of representatives of twenty-seven scientific and technical societies. An executive committee has been appointed, consisting of Sir Joseph Thomson, O.M., president of the Royal Society, chairman; Dr. Dugald Clerk, F.R.S., Sir Robert Hadfield, F.R.S., Mr. A. D. Hall, F.R.S., Professor Herbert Jackson, honorary secretary, Sir Alfred Keogh, K.C.B., Sir Ray Lankester, K.C.B., F.R.S., Professor A. Schuster, secretary of the Royal Society, Sir John Snell, Professor E. H. Starling, F.R.S., Lord Sydenham, F.R.S. and Mr. R. Threlfall, F.R.S. The first meeting of the board was held on July 20, when questions relating to scientific, educational and industrial matters were under consideration.

THE American Association for Clinical Research will hold its eighth annual meeting in New York, September 28, 29 and 30, with headquarters at the Hotel Majestic. There will be three sessions each day, morning, afternoon and evening. Clinics will be held at the Flower, Metropolitan and other hospitals. Dr. Daniel E. S. Coleman, of New York, is president of the society, and Dr. James Krauss, 419 Boylston Street, Boston, is permanent secretary.

DONALD B. MACMILLAN, who went in 1913 in search of "Crocker Land," will arrive home within a month, according to a message received by the officers of the American Museum of Natural History. His party will be with him, including Dr. E. O. Hovey, who had charge of the relief expedition sent to MacMillan in 1915 on the schooner *George B. Cluett*. The party is expected to reach St. Johns, N. F., between September 20 and October 1. The explorers are returning on the Danish steamer *Danmark*, chartered by the museum from the Greenland Mining Company. They will stop on the way at Thule to pick up

Dr. Hovey and his party, and it was expected that Knud Rasmussen, who has been in Greenland for two years, will join them.

According to a press dispatch from Punta Arenas, Chile, Lieutenant Sir Ernest H. Shackleton has rescued the members of his Antarctic expedition who were marooned on Elephant Island. Lieutenant Shackleton returned to Punta Arena on September 3 with his men safe and well on board the rescue ship *Yelcho*. This was the fourth attempt made by Sir Ernest Shackleton to rescue the twenty-two men who had been marooned on Elephant Island since April 24. The other attempts, made during June and July, failed on account of unfavorable ice conditions.

Dr. W. G. MacCallum, professor of pathology in Columbia University, expects to return to New York this month from a trip to Honolulu, Fiji, New Zealand, Australia, Java, Borneo, Celebes and Sumatra. During this trip, which has lasted since February, he has given some attention to prevailing diseases in these islands.

Dr. George T. Moore, director of the Missouri Botanical Garden, has returned from a trip, which has lasted since February, he has spent a few days at the biological station of the University of North Dakota, collecting and studying the algæ of that region.

Dr. George W. Crile, professor of surgery in Western Reserve University, on August 25, gave an illustrated lecture before the graduate school in medical sciences of the University of Illinois, Chicago, on "Exhaustion and Restoration." On August 31, Professor C. R. Bardeen, dean of the medical school of the University of Wisconsin gave a lecture before the school, his subject being "Study of the Anatomy of the Heart in the Living by Use of the X-ray."

Professor Burton D. Meyers, of the University of Indiana, recently gave an illustrated lecture on "The Normal Position of the Human Stomach" to the faculty and students of the Graduate School in Medical Sciences of the University of Illinois.

The Archangel Society is collecting the sum of $12,500 to obtain information of two Russian expeditions which sailed in 1912 under Lieut. Brusiloff and M. Rousanoff.

President Wilson has signed the bill recently passed by Congress appropriating $35,000 for the erection at Washington of a memorial to John Ericsson, inventor of the Monitor and distinguished as an engineer.

Professor Thomas Gregor Brodie, associated with Professor A. B. Macallum, in the department of physiology of the University of Toronto since 1908, died on August 20, at the age of fifty years. Professor Brodie was in London, where he was serving as a captain in the Canadian Army Medical Corps.

Mr. Charles Dawson, who died on August 10 at the age of fifty-two years, was a solicitor, who devoted attention to the fossil remains of reptiles found in the Wealden formations quarried round Hastings, and made a large collection, which he placed in the British Museum. In 1912 he discovered the now famous skull and mandible of *Eoanthropus dawsoni* in a very old gravel at Piltdown.

At the beginning of July, as we learn from *Nature*, a party of thirty men, led by Mr. Birger Johnsson, left Sweden for Spitsbergen in order to work the coal deposits at the head of Bell Sound (Braganza Creek) and Isfjord. At Braganza Creek the coal, though of Tertiary age, is said to be of good burning quality, and there is an average thickness of 2.15 meters over an area of about 100 kilometers. At the Pyramid Hill and in Bünsow's Land, at the head of Isfjord, on the other hand, the coal is culm of Carboniferous age, and is not so good as at Braganza. None the less, these two areas are calculated to yield about 3,000 million tons of good coal. Other members of the expedition are Mr. S. Öhman, who will be responsible for the mapping; Mr. H. Odelberg, agronomist, who will see to the provisioning; Mr. E. Lundström, who will serve as botanist and make a map according to Professor De Geer's photographic method; and a paleontologist, Mr. Erik Andersson, of Upsala, who was recently studying the fossil fishes of Spits-

bergen in the British Museum. Mr. Lundström is taking some plants to see if they will grow there.

UNIVERSITY AND EDUCATIONAL NEWS

Recommendations that a fund of more than $3,000,000 for the treatment of cancerous, nervous and disabling ailments be given to the University of Pennsylvania Hospital has been made by Dr. Winford H. Smith, superintendent of the Johns Hopkins Hospital, Baltimore, who was selected by the trustees of the fund, jointly the incorporated trustees of the Philadelphia Yearly Meeting of Friends and a body organized as the board of managers of the Jeanes Hospital, to come to Philadelphia and make a survey of its hospitals and medical work and give them his opinion as to where the fortune would work the greatest benefit. The fund is the estate and its increment willed for the purpose by Anna J. Jeanes, a noted Friend philanthropist, who died in 1908.

Mr. Blanchard Randall and Dr. Howard Kelly have presented to the Johns Hopkins Hospital a collection of portraits of medical men said to be of great value. The collection given by Mr. Randall, who is one of the trustees of the institution, consists of forty-eight portraits. Dr. Kelly, who is one of the consulting physicians, added eleven portraits.

Miss S. E. S. Mair and Mrs. A. M. Chalmers Watson, on behalf of women medical graduates, students and their friends, have offered to pay to the Edinburgh University $20,000 for the medical education of women.

The report of President R. S. Hyer to the board of trustees shows that the enrollment of the initial year of the Southern Methodist University reached 706 students, 453 of whom were in the academic department. Over 300 students in the academic department carried science courses during the year. In the choice of a science, chemistry, physics, biology and geology registered practically the same number. The total enrollment is said to establish a new record for the initial year in American universities. The University of Chicago registered 698 in its first year.

Dr. W. W. Cort, Ph.D. (Illinois, '14), professor of biology at Macalester College, St. Paul, Minn., has accepted a position as assistant professor of zoology at the University of California. Dr. H. D. Gould, Ph.D. (Princeton, '16) has been appointed instructor in zoology in place of Assistant Professor J. A. Long on Sabbatical leave.

Appointments at the Massachusetts Institute of Technology have been made as follows: Dr. Frederick G. Keyes, associate professor of physico-chemical research; Eugene Olaf Christiansen, instructor in business management; Clarence K. Reiman, instructor in inorganic chemistry; Ernest W. Wescott, research associate in applied chemistry; Robert E. Wilson, research associate in applied chemistry; Charles L. Burdick, research associate in physical chemistry; John G. Barry, instructor in geology and mineralogy, and Alexander Klemin, instructor in aeronautical engineering.

DISCUSSION AND CORRESPONDENCE

THE FUNDAMENTAL EQUATION OF MECHANICS (IV)

In his paper on "The Accepted Facts of Dynamics,"[1] Professor Hoskins proposes as a sort of challenge a simple problem which he believes can not be solved by means of my fundamental equation $F/F' = a/a'$ without the aid of a further principle which he calls the *additive property of mass*. This challenge seems to me a fair one, and without reopening the general discussion, I should like to show how easy it is to offer a solution of this problem based entirely on the principles I have set forth as sufficient.[2] The problem is as follows:

> A first body, A', is observed to have an acceleration a' when acted on by a force F; a second body, A'', is observed to have an acceleration a'' when acted on by an equal force F; if the two are combined into a single body, what acceleration will this body have if acted on by a force F?

[1] Science, June 30, 1916.

[2] Science, February 5, 1915; July 30, 1915; and especially March 3, 1916. Further discussion of this topic may be expected to appear in the *American Mathematical Monthly*.

It will be noticed that we are here concerned not with a single particle, but with a collection of two particles, so that we may expect the *principle of action and reaction* to be called into service. (This principle was included in my paper, in a footnote.) The solution I would propose is as follows:

Since the force F applied to the composite body must be applied at some point, let us suppose that it is applied at the A' end of the body; and since the two parts A' and A'' must be connected together by some means, let Q be the force which each part exerts on the other. If now we confine our attention to the first body, A', we see that the net force acting on this body in the forward direction is $F-Q$, while the acceleration produced is the required acceleration of the combined body, say a; hence, by the fundamental proportion as applied to the first body,

$$(F-Q)/F=a/a'.$$

Similarly, if we confine our attention to the second body, A'', we see that the net force acting is Q, while the acceleration produced is the same as before, namely a; hence, by the fundamental proportion as applied to the second body,

$$Q/F=a/a''.$$

Solving these two equations for a, we have at once the required answer:

$$1/a=1/a'+1/a''.$$

It is obvious that the proof just given—involving the elimination of the internal forces Q—is nothing more than a special case of the proof regularly employed for the familiar theorem on the motion of the center of mass of any collection of particles. In fact, as far as I can make out his meaning, *all that Professor Hoskins values so highly in his (rather vague) principle of the additivity of mass is really contained in this well-known theorem on the motion of the center of mass.* If this is true, the chief difference between the methods advocated by Professor Hoskins and myself comes down to this: *he would regard as a fundamental assumption, to be stated as such at the very outset of the course, a rather complicated proposition called the additivity of mass, while I would prefer to treat this proposition as a theorem to be deduced by easy steps from much simpler fundamental assumptions.*

In conclusion, there are two minor points in Professor Hoskins's paper on which I may be permitted to comment.

First, I can not assent to Professor Hoskins's characterization of my method as one that "purports to be independent of mass." It is true that my method purports to require, at the start, only three fundamental concepts, namely: force, length and time; but the concept of mass is no more "ignored" or "evaded" in the development than are the concepts of energy, momentum, etc., all of which take their proper places in the theory as derived concepts. *The kinetic idea of mass or inertia (namely, force over acceleration) is as difficult as it is important, and should be led up to gradually, by easy and very definite steps.*[3]

Secondly, I can not admit that my method requires me to define "the unit force" as "the force which would give the unit mass 32.1740 units of acceleration." On the contrary, my idea of a force is a spring balance, and my idea of a unit force is any spring which may happen to be selected as a standard. It is a matter of entire indifference in my method whether the unit force is a pound or a dyne or a pennyweight.

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HARVARD UNIVERSITY

SIR CLEMENTS MARKHAM

TO THE EDITOR OF SCIENCE: It was a great pleasure to me to read the appreciation of Sir Clements Markham which came out in SCIENCE for April 21. Too often have the admirers of Sir Clements in this country had reason to believe that his anthropological labors are not properly appreciated here. Such a full, generous and complete résumé of his great accomplishment as that given by A. C. B. contributes toward a contrary belief.

Through Sir Clements Markham's extraordinary diligence and scholarship, students of South American anthropology are given ready access to Garcilasso de la Vega's "Royal Com-

[3] Compare the excellent remarks of Professor Willard J. Fisher in SCIENCE for July 7, 1916.

mentaries," to Pedro Sarmiento de Gamboa's diametrically opposed "History of the Incas," to the reliable and unbiased Cieza's writings, and to many other equally valuable works. Nor are Sir Clements's own works to be left unread by any student of the subject. He did more than any other one man for South American anthropology.

Perhaps the most endearing trait of the great scholar's character was his unselfishness. It happened that I ran across a copy of a certain rare book on Peru. Although I did not then know Sir Clements I ventured to write to him and ask him whether it would be worth while to publish an English translation of the work. He replied that it would. Although he himself had already made a translation (still in MS.) he encouraged me to go ahead with mine and he personally made arrangements for its publication in England. Such generosity is of the best sort. It shows that Sir Clements placed the advancement of knowledge above his own advancement, and it shows that he was glad to help even an unknown beginner by a personal sacrifice.

X.

SCIENTIFIC BOOKS

The Horse in Health and Disease. F. B. HADLEY. W. B. Saunders and Co., Philadelphia.

This book, designed as an introductory text to the study of veterinary science in agricultural schools and colleges, ought to fulfill its purpose. The author is to be congratulated upon his judgment in selecting the most suitable material. He has succeeded in bringing together in a condensed form a number of branches of veterinary science.

Although couched in scientific terms, most of which are defined with their first appearance, the book ought to be intelligible to a careful reader. The arrangement is complete, leaving little to be desired. The horse is taken as the type. Beginning with the anatomy and physiology, the structure and function of the normal or healthy animal is explained. This knowledge is indispensable to one expecting to recognize abnormal conditions. Then follows a brief description of a great variety of diseases, together with measures of control.

By way of adverse criticism, very little can be said. In discussing the subject of diagnosis of disease, there occurs: "Even an experienced diagnostician fails to make an absolutely accurate diagnosis in more than 50 per cent. of his cases." This must be very discouraging to a novice and the facts of the case do not render the statement justifiable. To be sure, the word *absolutely* makes the statement invulnerable, but the impression created is detrimental and uncomplimentary to the author's profession. Under retention of the urine occurs the following: "The bladder of the stallion or gelding can be emptied only by use of the catheter." Practitioners frequently evacuate the bladder of males by pressure upon the bladder per rectum, even upon recumbent animals.

The illustrations, most of which are photographs, are clear and numerous. The excellent paper and the clearness of the type are characteristic of the publishers.

V. G. KIMBALL

PHILADELPHIA, PA.

QUOTATIONS

THE CONTROL OF EPIDEMIC INFANTILE PARALYSIS

THE severe epidemic of infantile paralysis—or acute anterior poliomyelitis, to give the disease a more descriptive title—that now prevails in New York has not unnaturally given rise to a certain degree of anxiety in our own country also. During the last two months this epidemic has caused the death of some 1,400 children in New York, the mortality being about 25 per cent.; comparatively few adults have been attacked. Quarantine regulations are now being widely enforced in the neighboring districts, and children under 16 years of age, we read in the *Times*, are forbidden to travel, to the vast inconvenience of holiday-makers. The public health authorities in New York are only too familiar with epidemic infantile paralysis, for the disease is always present and always more or less active in that cosmopolitan town. They are endeavoring to limit the epidemic by the isolation or quaran-

tine of the most susceptible part of the population—that is to say, of the children. No more effectual way of dealing with the situation is known.

The disease is one that has been studied with great success during the last few years in America, more particularly by Flexner and his pupils, to whom we owe many of the recent discoveries made as to its ætiology and the way in which it may be communicated from one person to another. The great advances made in this regard during the last five or six years may perhaps be shown by a brief history of the disease. It was first isolated as a distinct entity from the mixed mass of paralyses affecting children by von Heine in 1840, receiving the name "spinal paralysis of children"; naturally there could be no exact knowledge of its pathological anatomy at this early date. Two or three decades later Prévost and Vulpian, Charcot and Joffroy and others described accurately the microscopical lesions that could be found in the spinal cords of patients dying of the disease. In 1890 Medin, taught by the study of a Swedish epidemic of infantile paralysis, extended our knowledge of its various clinical types, particularly in the symptomatology of their initial stages. Further advances were made by Wickman in 1905 and the succeeding years, particularly so far as the epidemiology of the disease is concerned. Many other physicians and pathologists could be mentioned as having cleared up various obscure points in connection with infantile paralysis, or, as it is sometimes termed, Heine-Medin's disease, or the Heine-Medin-Wickman disease; its bacterial cause was looked for with great persistence, and between the years 1898 and 1907 was identified by a number of observers, quite wrongly, with various cocci cultivated from the cerebro-spinal fluid of patients who had or had died of the disease. Fuller experience, however, proved that errors had been made here, and in 1911 Römer summed the matter up correctly when he said that the true bacterial cause of the disease was still unknown. Both cultural experiments and experiments on animals had failed to reveal it. Yet the seasonal and epidemic incidence of infantile paralysis and the inflammatory character of the lesions observed in it *post mortem* made it certain that some living and transmissible virus was the cause of the disease.

So far as its transmissibility was concerned, Landsteiner and Popper have shown that certain apes—hamadryads and macaques—could be infected with a disease indistinguishable from infantile paralysis, as we see it in children, by inoculation with an emulsion of the spinal cord of patients dying of the disease. The virus was found to be a filter-passer, and to survive preservation in glycerine for many months. In 1912 Kling, of Stockholm, succeeded in recovering the virus from washings from the mouth, nose, trachea and small intestine of fatal cases of infantile paralysis. But the actual microbe causing the disease remained unknown until 1913, when it was isolated, grown on artificial media, and carefully described by Flexner and Noguchi. The success of these investigators where so many others had failed is to be attributed to their discovery of a suitable culture medium. Growths were made anærobically under a layer of paraffin, in a solid agar medium containing sterile unfiltered ascitic fluid, or brain extract and sterile rabbit kidney. Minute colonies of the virus were obtained, composed of globular or globoid bodies averaging in young cultures 0.15 to 0.30 μ in size, arranged singly or in short chains or masses. Third generation cultures from human tissues, and cultures in the fifth generation from the tissues of experimentally infected monkeys, were found to produce typical acute anterior poliomyelitis in experimental animals.

At the present time, therefore, we are in the possession of a good deal of positive knowledge with regard to the pathogenesis and epidemiology of infantile paralysis. The virus producing the disease has been isolated, cultivated and employed for the transmission of the disease to experimental animals in investigations that have proved invaluable and indispensable for the increase of our knowledge of its spread among human beings. The virus has been found in the naso-pharynx of human carriers of the disorder, who though they have never apparently suffered from it

themselves, yet are capable of transmitting it to others. The virus has also been found in the alimentary tract of patients and experimental animals with infantile paralysis, a fact which may explain why it is that a gastro-intestinal upset sometimes precedes and appears to be the cause of an attack of infantile paralysis. The virus has been proved to reach the patient's central nervous system, in which its main pathological action is exerted, by travelling along peripheral nerves—the sciatic, the nasal nerves, the optic nerves and tracts, for example—to the spinal cord or brain as the case may be, and this is to be regarded as the normal mode of infection in poliomyelitis; gross infection of the blood stream with the virus may also suffice to infect the brain. Evidence has been adduced to show that certain flies, particularly *Stomoxys calcitrans,* the common stable fly, may act as carriers of the disease. In addition the virus has been found on clothes, handkerchiefs and toys used by patients in the acute stages of infantile paralysis. The careful examination of washings from the mouth or intestine have shown that human beings may remain carriers of the virus for as long as six months. According to Kling, quarantine for infantile paralysis should last at least a fortnight—in New York it now lasts for ten days or thereabouts, we are told—though it is clear that no certainty attaches to any fixed period in this connection. There is reason to believe that the great majority of adults and many children may be infected with the virus without being a penny the worse for it, either because the virus is enfeebled or because the resistance of such individuals is high. Thus it is probable that every patient actually ill with the disease has in his immediate environment a number of mild and abortive cases of infantile paralysis that escape observation or detection and diagnosis, and also a still larger number of perfectly healthy people who are all carriers of the infecting agent and therefore potential sources of infection to others. It would seem as if all these persons developed a relatively high degree of immunity to the virus, a fact which may explain the comparative immunity of European towns or villages visited by epidemics of infantile paralysis to the occurrence of further epidemics during the next few years. In fact, as with cerebrospinal meningitis, the number of the carriers of the infection may be much larger in infantile paralysis than the number of the victims of an epidemic of that disease.—*The British Medical Journal.*

NOTES ON METEOROLOGY AND CLIMATOLOGY

THUNDERSTORMS OF THE UNITED STATES

A THOROUGH study of the distribution of thunderstorms has been made by Mr. W. H. Alexander with the aid of the officials in charge of more than one hundred of the regular weather bureau stations.[1] Following this, Professor R. DeC. Ward has fittingly brought out the significance of the thunderstorm as a climatic phenomenon.[2]

Thunderstorms are produced (1) by the excessive heating of the lower air; (2) by the over- and under-running of winds of different temperatures, which in some way cause moist air masses to rise rapidly; and (3) by the cooling of the upper air. These causes usually are not individually responsible for any thunderstorm; but act in conjunction.[3] Excessive heating of the lower air occurs in summer and most favorably on plains, plateaus and intermont basins. Thus in the United States the maximum number of thunderstorms is to be expected in the Mississippi Valley, and in the western mountain and plateau region. Furthermore, most come in summer: in 126 of 139 stations considered[4] the month with most thunderstorms is June, July or August. Cyclonic activity in a region subject to marked temperature changes is usually responsible for the production of thunderstorms by over-run-

1 *Mo. Weather Rev.*, July, 1915, pp. 324–340, 13 maps.

2 Pan-American Scientific Congress; abstract in *Mo. Weather Rev.*, December, 1915, p. 612.

3 A comprehensive investigation of the physics of the thunderstorm was published in 1914 by Professor W. J. Humphreys. See review in SCIENCE, December 4, 1914, p. 823.

4 H. Lyman, "Percentage Frequency of Thunderstorms in the United States," *Mo. Weather Rev.*, December, 1915, pp. 619–620.

ning and under-running winds. This leads to the winter and spring thunderstorms; particularly in the southern Mississippi Valley where the lower air is warmest and dampest. The cooling of the upper air while the lower remains relatively warm is characteristic of a marine location. With the aid of cyclones, thunderstorms produced in this way are to be expected in winter and at night. The Pacific coast region thus tends to have its thunderstorms, few at most, in winter.

For illustration, the accompanying table shows the monthly percentage frequencies of days with thunderstorms at seven stations in the United States.[4] A thunderstorm day is now defined as one on which thunder is heard whether or not rain falls at the observing station.

Station	Per Cents. of Ten-year Total Occurring in Each Month												Total Thunderstorms, 1904–1913
	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	
San Francisco, Cal.	12	50	12	0	0	0	0	0	0	13	0	13	8
Fresno, Cal.	3	14	16	14	16	5	3	0	11	8	5	5	37
Boston, Mass.	2	1	4	4	14	17	23	22	11	2	2	1	180
New York, N. Y.	1	1	3	9	14	18	25	19	9	3	0	0	284
Chicago, Ill.	2	1	6	8	15	16	17	16	12	4	2	0	400
Santa Fé, N. Mex.	0	1	3	4	9	15	29	24	12	3	0	0	732
Tampa, Fla.	1	2	3	3	10	17	24	22	14	3	0	1	944

At San Francisco, atmospheric instability does not often occur in summer. Fresno has its maximum early probably because the air is too dry in mid-summer. The other stations have the greatest number in summer. Boston, New York and Chicago all have an abundance of moisture. The greater number of thunderstorms in Chicago for the year, and particularly in spring, as compared with New York and Boston, is due to its continental position and exposure to rapid temperature changes. The interior location favors more rapid warming in spring than is the case in the east. Even New York appears markedly more continental than Boston. It is noteworthy that there are more thunderstorms in May than in September: May is moister; and the upper air is colder. The great thunderstorm activity at Santa Fé is favored by the mountain location (altitude 7,013 feet) east of the Rio Grande. In June, July and August there is, on the average, a thunderstorm every other day. Thunderstorms are less than half as frequent at the drier, lower places such as El Paso. Tampa has more thunderstorms than any other weather bureau station in the United States. In the three summer months, thunderstorms occur on about two days out of three. The summer on-shore winds supply abundant moisture and the intense sunlight at this low latitude effectively overheats the lower air. Thus the joint distribution of atmospheric instability and moisture dominate thunderstorm frequency.

Parts of Professor Ward's abstract are quoted here:

"As essential characteristics of American climate, thunderstorms have a broad human interest. From the viewpoint of climatology, the distribution of thunderstorms is of more interest than their mechanism. The part played by their rains in watering our crops is of greater importance than the size of the raindrops. The damage done by their lightning[5] and hail[6] concerns us more than the cause of the lightning flash or than the origin of the hailstorms. The thunderstorms of the eastern United States are among the most characteristic of American climatic phenomena. In size, intensity and frequency of occurrence they are unique.

"In relation to man's activities, it is of significance that most thunderstorms occur at a time of year and at the hours when outdoor activities are at their height.

"Thunderstorms bring us much that is of benefit. To them we owe much, in parts of our country even most, of our spring and summer rainfall. Without these beneficent thunderstorms our great staple crops east of the Rocky Mountains would never reach maturity. One good thunderstorm over a considerable area at a critical crop stage is worth hundreds of thousands of dollars to American farmers. Our stock markets time and again

[5] See note on "Thunder and Lightning," SCIENCE, N. S., Vol. XLII., 1915, p. 252.

[6] See note on "Hail," below.

show the favorable reaction of such conditions upon the prices of cereals and also of railroad and other stocks. Thundershowers break our summer droughts, cleanse our dusty air, refresh our parched earth, replenish our failing streams and brooks, bring us cool evenings and nights after sultry and oppressive days."

HAIL

HAIL consists of particles of ice from the size of peas to that of oranges or larger which fall from the clouds. True hail, which is usually a summer phenomenon, and is characterized generally by a central core of cloudy ice surrounded by one or more layers of clear ice, should not be confused with the small ice pellets of winter. Hail rarely occurs without a thunderstorm, of which hail may be said to be a violent manifestation. Thus the distribution of hail is limited, and patchy, falling sometimes on parallel strips of land in the same thunderstorm. As hail is an accompaniment of thunderstorms, it occurs in the warm southeast quadrant of a cyclone, or associated with the over- and under-running winds on a wind-shift line. For example, the passage of a wind-shift line over the region from Illinois to Maryland, June 20 to 22, 1915, was accompanied locally by very large hail: "teacups" in Illinois and "baseballs" in Maryland.[7] The annual and diurnal periods of hail occurrence are much the same as those of thunderstorms, although more marked. Thus, in the United States, the month with most hail is May, and the time of day, mid-afternoon; while least hail falls in winter and in the early morning. In distribution over the earth, there is least hail in the polar regions where the air seldom has sufficient moisture or is sufficiently unstable to satisfy hail requirements. On the other hand, near the equator at sea-level hail rarely occurs because the freezing level is too high and the lower air too warm to permit hailstones to reach the earth's surface. Hail may fall on the ocean with the passage of a wind-shift line. Its greatest development comes in the subtropical deserts: there the most frightful hailstorms occur—storms in which men and beasts not killed outright may be frozen to death under the hail.

[7] See O. L. Fassig, *Monthly Weather Rev.*, September, 1915, pp. 446–448; and "Climatological Data for the United States by Sections," Vol. 2, June, 1915, Illinois, Indiana, West Virginia and Maryland sections.

The annual and diurnal periods and the local distribution just mentioned are easily explained as follows: the moister and the warmer the lower air, and the colder the upper air, the faster and the farther will the warm air rise; and the greater is the opportunity for hail formation. The moisture comes from the lower air, the cold from the expansion of this air on rising. For instance, a mass of air at 30° C. and with a relative humidity of 50 per cent. will reach 0° at 4.8 kilometers, and — 20° at 7.9 kilometers' altitude, mixing being disregarded. Hail clouds frequently tower 8 or 10 kilometers above the earth's surface. Apparently, hail originates when snow crystals begin to form among raindrops, which are usually carried up into the level where the temperature is below freezing. A snow-flake and an undercooled drop freeze together into the opaque ice that forms the core of a hailstone. As this ice particle falls through the layer of undercooled raindrops, which may be 3 to 4 kilometers thick, a layer of ice is added. Then it may be caught in one of the tornadic whirls, which evidently occur within thunderstorms, and carried aloft. On being released, perhaps near the top of the cloud, it may accumulate another layer of ice on the way down. This cycle may be repeated many times. Finally, when too heavy to be held in the uprushing currents, or when the whirl collapses, the hail, congealing moisture on its cold surface as it falls, may descend to earth. For example, some of the larger hailstones, 3 to 4 inches in diameter, falling in Annapolis, June 22, 1915, had 20 to 25 layers of ice. The hail was of diverse shapes.[8] That hail must return to the upper part of the cloud after having grown to a considerable size is evident from the temperatures of — 5 to — 15° C. observed in hailstones. Hail does not occur in spite of hot weather, but because of the heat.[9]

[8] See Fassig, *ibid.*

Hail damage is both local and occasional. In some countries, particularly in France, reliance is placed in cannon, rockets or lightning rods to protect crops from hail. Professor Angot, head of the French Meteorological Service, stigmatized these as useless. For example, "the Observatoire de Bordeaux, situated in Floirac . . . was . . . provided with a 'niagara' (lightning rod) September 22, 1912. The commune of Floirac was devastated by hail on August 15, 1887; but for the succeeding 25 years it had been immune. Again in 1912, two disastrous falls of hail occurred at Floirac, one on July 5, before the installation of the 'niagara,' the second on October 20, when a heavy shower of very large hard hailstones fell upon the 'niagara' itself during a period of 2½ minutes."[10] Hail insurance, however, is the usual mode of protection. Insurance companies are without adequate means for fixing the premiums because the average occurrence of hail can hardly be mapped without an excessive number of stations and a very long period of observations. Hail damage is at times extreme. For instance, in South Carolina, July 6 to 7, 1914, crop losses estimated at $955,000 were sustained over an area of about 50,000 acres of crop land. The damage was done mostly by immense quantities of hailstones the size of ordinary marbles.[11] Hail at times destroys live stock also. Thus in Illinois on June 20, 1915, 50 shoats, some sheep and cattle were reported to have been killed by hail. The skulls and backs of some of the hogs were said to have been broken.[12] In cities, skylights, windows and greenhouses sustain the most damage. Plate glass even 1 to 2 centimeters thick may be shattered. Horses frequently and people occasionally are injured.

[9] The material for the summary above, except as specified in foot-notes 7 and 8, was taken from J. von Hann's "Lehrbuch der Meteorologie," Leipzig, 1915, pp. 708–725.

[10] See translation, *Monthly Weather Rev.*, March, 1914, p. 166.

[11] "Climatological Data: South Carolina Section," Vol. 1, July, 1914, p. 56.

[12] "Climatological Data: Illinois Section," Vol. 2, June, 1915, p. 43.

Damage by other features of thunderstorms such as the squall and lightning, is, in general, much greater than the occasional hail destruction. Nevertheless, hail can destroy crops as completely as a tornado or a flood.

R. H. SCOTT, 1833–1916

One of the pioneers in synoptic meteorology, Dr. R. H. Scott, died in England, June 18. He was well known as the chief of staff of the Meteorological Office from the formation of the Royal Society's Meteorological Committee in 1867 until his retirement on a pension in 1900. He was also secretary of the International Meteorological Committee from its commencement in 1874, until 1900. In 1861, Fitzroy had begun the issue of forecasts and storm warnings, based on information collected daily by telegraph and charted on maps. The issue of forecasts and storm warnings was suppressed; but at the request of the board of trade the issue of storm warnings was at once revived. The telegraphic service was developed, and the first result of Scott's work appeared in 1876 in a little book, entitled "Weather Charts and Storm Warnings." The issue of forecasts was recommenced on April 1, 1879, and has continued ever since. This was followed in 1883 by Scott's "Elementary Meteorology," which took foremost place as a text-book of meteorology. From that time onward Scott devoted his attention mainly to the administration of the office and to the work of the Meteorological Society.[13]

ALEKSANDR IVANOVICH VOEIKOV, 1842–1916

Voeikov (Woeikow), the eminent meteorologist and geographer, died in Petrograd, January 28 (February 10), 1916. He was born in Moscow, and while still young traveled widely in Europe, Asia and the two Americas. In 1884 he published his great work, "The Climates of the World" (German translation, 1887). The following year he was appointed professor of physical geography at the Univer-

[13] From W. N. Shaw, *Nature*, London, Vol. XCVII., 1916, p. 365. A history of British weather forecasting and an account of the organization and work of the Meteorological Office in London is published in the *Monthly Weather Rev.*, September, 1915, pp. 449–452.

sity of St. Petersburg, and later, director of the meteorological observatory there. His meteorological work which was very comprehensive centered most, perhaps, on the relations between the temperatures of air, ground, oceans and lakes. In 1904, Voeikov published "Meteorologia," a handbook of 719 pages in Russian, and at present the leading meteorological text in that language. As a geographer, he is noted particularly for his publications on the rôle of the Pacific Ocean in the world's affairs, an article on the regeneration of Russia, and a French work "Le Turkestan russe."[14]

NOTES

Prince Boris Borisovitch Galitzine died at Petrograd, after a short illness, on May 4 (17), of this year, at the age of 54 years. For the past three years he was director of the meteorological service of the Russian Empire. He is best known for his distinguished work in seismology.[15]

Sir William Ramsay, "the father of the new physical chemistry," and England's foremost chemist, died July 24, 1916. His contribution to meteorology, conjointly with Lord Rayleigh, was the discovery of the four noble atmospheric gases: argon, neon, krypton and xenon. Nitrogen derived from air was found to be denser than that obtained from other sources. By heating atmospheric nitrogen repeatedly with metallic magnesium Ramsay obtained a denser and denser gas which proved to be quite different from nitrogen. At the same time, Lord Rayleigh was able to separate nitrogen from possible impurities by repeating with modern apparatus an experiment devised by Cavendish. These two investigators continuing jointly discovered argon, first of a new class of elements. Incidental experimenting with liquid air led to the discovery of three other elements of this same type—neon, krypton and xenon.[16]

[14] See *Monthly Weather Rev.*, May, 1916, pp. 288–289.

[15] See *Nature, London*, Vol. XCVII., 1916, p. 424.

[16] *Scientific American*, August 5, 1916, p. 117.

Early this year Dr. Th. Hesselberg became director of L'Institut meteorologique de Norvege, Kristiania.

German meteorological magazines dated February, 1915, seem to have been the last ones received in this country.

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SPECIAL ARTICLES

THE BROMINE CONTENT OF PUGET SOUND NEREOCYSTIS (GIANT KELP)

It seems strange indeed that scarcely any mention is made in the American technical literature of the presence of bromine in the seaweeds of the Pacific coast, especially those seaweeds which have been termed "kelp." Available analytical data on the quantities of bromine from the above source is negligible.

The writer considers this to be due to one or more of several possible reasons. Perhaps, if bromine has been previously detected, it was not considered to be present in quantities large enough to be of importance. The content of bromine must vary considerably in amount in the various varieties and species of seaweeds. Either it does not occur in certain species or varieties, or the same variety from different localities contains it in widely different proportions. Again, the difficulty met with in determining bromine quantitatively in the presence of an excess of the other haloid salts is a contending factor in the production of analytical data upon this subject.

A personal experience, which attracted my attention to the bromine content of seaweed, may prove interesting at this point. Some two years ago, while teaching chemistry in the College of Puget Sound, Tacoma, Wash., it was my privilege to often walk along the beach at The Narrows, especially during the time of low tide. The Narrows is situated about four miles west of the city of Tacoma, and borders the mainland on the west and a strip of beach, known as Day Island, on the east. The channel of the sound is less than a half-mile wide

at this place and hence receives the full wash of the Sound's waters from each tide. The numerous quantities of igneous rocks in the channel and the rapidly moving water makes this location an ideal "field" for the growing of *Nereocystis luetkeana*. At low tide the beach is strewn with seaweed along with a few other, but smaller, varieties.

The stems and leaves are covered with a slimy coating from one sixteenth to one eighth of an inch in depth, and composed of algæ and other microorganisms. This covering acts as a protective coating to the seaweed while it lies exposed to the sun's radiations during low tide. Many of the leaves, twelve to twenty feet long and sixteen to twenty inches in width, develop light yellow spots with a filmy texture sometimes covering large portions of the leaves. The chlorophyl disappears entirely from these spots and does not apparently reappear as such upon submergence during the incoming tide. Upon close examination it is found that the slimy covering mentioned above has dried completely over the bleached spots, and in many instances there is none of the dried film present, suggesting that the slimy covering had been removed mechanically by wave motion, etc.

One would be at a loss to explain this discoloration of green coloring-matter in the seaweeds was it not for the strong odor of bromine in the vicinity where this bleaching was in progress, especially after the sun had radiated upon the beached plants for an hour or more. The "stench" of the fumes as being due to bromine is unmistakable to those who are at all familiar with the element. The presence of the bromine in the air about these localities must be due to the action of photo-chemical or microorganic processes upon the combined bromine and other halogens present in the seaweed. The liberation of small amounts of the halogens in the presence of the chlorophyl undoubtedly causes its discoloration.

In order that it might be determined whether or not the bromine existed in combination within the seaweed, several large *Nereocystis* (stems and leaves intact) were secured, washed, dried and ashed. The ashes gave a strong test for both bromine and iodine.

From the qualitative test one would expect the quantity of bromine to be equal to, if not greater than, the iodine content in the same ash. The ashes from *Nereocystis* secured at different times were kept on hand and given to the students for analytical determinations, viz., sodium, potassium, chlorine, bromine and iodine.

Two large *Nereocystis luetkeana* yielded upon quantitative examination the following substances expressed in per cent. of dry weight of material:

	K_2O, Per Cent.	I, Per Cent.	Br, Per Cent.
No. 1	22.3	0.30	0.19
No. 2	24.7	0.23	0.11

Though not going into detail as to the methods used in analysis (a detailed analysis will be reported in one of the chemical journals) I might say that standard procedures were followed.

It appears that the bromine should be both recoverable and merchantable in view of the present prices of this commodity.

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THE NORTH CAROLINA ACADEMY OF SCIENCE

THE NORTH CAROLINA ACADEMY OF SCIENCE

THE North Carolina Academy of Science met in annual session at the Agricultural and Mechanical College, Raleigh, on Friday and Saturday, April 28 and 29, 1916. The executive committee had a meeting on Friday afternoon, and after this there was a session for the reading of papers. At night President D. H. Hill, of the college, delivered an address of welcome and then President A. S. Wheeler, of the academy, gave his presidential address, "The Critical Dyestuff Situation," with a demonstration of materials. Next Professor E. W. Gudger read a paper entitled, "The Remora or Echeneis; A Living Fish-hook," illustrated with specimens and photographs.

On Saturday morning at 9 the annual business meeting of the academy was held. The secretary-treasurer made his report, which showed the finances of the academy to be in good condition with a comfortable balance in savings bank. The various stated committees made their reports. An invitation to hold the 1917 meeting at the University of North Carolina, at Chapel Hill, was accepted. Twenty-three new members were elected and two former members reinstated, bringing the total membership up to 88.

The following officers were elected for 1916–17.

President—F. P. Venable, University of North Carolina, Chapel Hill.

Vice-president—H. C. Beardslee, Asheville School for Boys, Asheville.

Secretary-treasurer—E. W. Gudger, State Normal College, Greensboro.

Additional members executive committee—J. E. Smith, University of North Carolina, Chapel Hill; E. O. Randolph, Elon College; Bert Cunningham, City High School, Durham.

At the close of the business session a joint meeting was held of the academy and of the North Carolina Section of the American Chemical Society, at which papers of interest to both bodies were read. Following these the chemists and the academy held separate meetings to complete the reading of papers on their respective programs. The academy adjourned at 1:30 P.M. The total attendance was 43 out of a membership of 86. There were 23 papers on the program, of which only 3 were read by title. Including the presidential address, which will be published in the current number of the *Journal of the Elisha Mitchell Scientific Society*, the following papers were presented:

Observed Changes in the Land Vertebrate Fauna of North Carolina: C. S. Brimley.

Notes the known changes in the abundance and distribution of certain birds, mammals and reptiles in North Carolina. The full paper is published in the current number of the *Mitchell Journal*.

Two Raleigh Amblystomas: C. S. Brimley.

Compares briefly the species of *Amblystoma* occurring at Raleigh, *A. opacum* and *A. punctatum*.

The data for these is given in full in the proceedings published in the *Mitchell Journal*.

Aristotle's Echeneis not a Sucking-Fish: E. W. Gudger.

The identity of this fish was discussed and data presented to show that it was a goby, while evidence was adduced that the "dolphin's louse," elsewhere referred to by Aristotle in his *History of Animals*, was a sucking-fish.

The Echeneis or Remora; a Living Fish-hook: E. W. Gudger.

The tendency of this fish to adhere to turtles, sharks or any large fish by means of its cephalic sucking disk, is made use of in many parts of the world to render easy the catching of fish. A thin cord is tied around the "small" of the tail of the fish and it is set free in the water. Finding a turtle or fish, the fisherman-fish clamps itself fast to it, and both are hauled in by the fisherman. This use of the living fish-hook was traced back to 1494, when Columbus (the first European to see it so used) witnessed its exploits on the south side of Cuba on his second voyage. The paper was illustrated by numerous photographs of illustrations in old books, showing this use of the fish. The completed paper will be published later.

Some Interesting Mushrooms: W. C. Coker.

Several species new or rare in North Carolina were shown, with photographs and paintings.

Naucoria sp. A species of this genus, not recorded from this state, has appeared in manured soil in the arboretum of the university for several years. It is of good size and very resistant to decay, and was tested and found harmless, and if the bitter gills are removed makes a very pleasant dish. As it appears very early in the season, during April, and before other species of any size are out, it is a valuable addition to our list of edibles. The species seems nearest *N. hamadryas*, but differs from it in some respects.

Clavaria spiculispora Atkinson. A painting of this species was shown. It was described from our collections of Chapel Hill plants. It is remarkable for the very deep brown color (deepest of any other American Clavaria), and the very long spicules on the spores. We have since found it in the mountains near Black Mountain. It is not known except from this state.

Amanita chlorinosma Pk. Photographs and paintings were shown to illustrate the great range in size and color of this species. White, greenish, salmon, reddish and ashy-brown forms occur. All the forms have a distinct odor of chlorine.

Nyctalis asterophora Fr. A photo was shown of this plant growing on *Russula nigricans*. It is very peculiar in having another mushroom for its host, and in the degenerated gills. The functional spores are not borne on the gills as usual, but on the cap as a fine powder, and are very large and irregular.

Venereal Infections in Animals: G. A. ROBERTS.

Observations, investigations and reports indicate very wide-spread venereal infections in this country and abroad among domestic animals, horses, cattle, sheep, swine, etc. Such infections have been known to exist in the human family for a long time.

Few people have recognized the extent and manifold results of these infections.

The most extensive investigations and the greatest losses, direct and indirect, in animals have been among dairy cattle and breeding herds.

The specific organism responsible for the infections in cattle has all but universally been accepted as the *Bacillus abortus* (Bang). Many cases of infection with the *B. abortus* are too mild to produce clinical symptoms. The results observed in many such infections, however, are: abortions, including premature births, still births and births of weaklings; metritis (inflammation of the uterus); and sterilities, temporary and permanent.

Retained "after-birth" is quite common in cattle when expulsion of the fetus occurs during the latter half of pregnancy, owing to the peculiar attachment between the fetal membrane and the uterus at the time.

Nymphomania is not uncommon in cows and mares.

The relation of this organism to certain udder diseases and the granular venereal disease of cattle, to some forms of calf scours and infant diarrheal troubles, has not been determined, but is suspicious of a close relationship.

Resistance and Immunity in Plants: F. A. WOLF.

This paper contains a brief summary of the facts which have been correlated with resistance and immunity in plants in attempts to explain the underlying causes. Attention is called to several investigations dealing with morphological differences between susceptible and immune varieties. Consideration is also given to the influence of mineral nutrients in the soil upon resistance. The discussion also includes those causes which reside within the protoplasm of the host plants such as differences in acidity, tannin content, etc., of susceptible and immune varieties. It is believed that too little attention has heretofore been given to the inherent characters of the parasitic organism which determine the virulence of the parasite.

Some Methods of Making Lantern Slides: Z. P. METCALF.

The need of some form of projection in science teaching and the general utility of lantern slides was emphasized. Two methods of making lantern slides were discussed and examples of various kinds of lantern slides were shown.

Trees and Shrubs of Chapel Hill: H. R. TOTTEN.

There are seventy-two species of native trees found in the Chapel Hill neighborhood. In this number there are fourteen oaks: *Quercus alba* L., *Q. stellata* Wang., *Q. lyrata* Walt., *Q. Michauxii* Nutt., *Q. prinus* L., *Q. ruba* L., *Q. palustris* Muench., *Q. velutina* Lam., *Q. falcata* Michx., *Q. pagodaefolia* (Ell.) Ashe, *Q. marilandica* Muench., *Q. nigra* L., *Q. phellos* L. A hybrid, probably between *Q. phellos* L. and *Q. falcata* Michx., is also found. This is the only station for the Pin Oak (*Q. palustris*) in North Carolina. There are seven hickories: *Hicoria ovata* (Mill.) Britton, *H. carolina-septentrionalis* Ashe, *H. microcarpa* (Nutt.) Britton, *H. glabra* (Mill.) Britton, *H. pallida* Ashe, *H. alba* (L.) Britton, and *H. cordiformis* (Wang.) Britton.

There are sixty native shrubs. A few of the most interesting are: *Nestronia umbellata* Raf., *Hydrangea arborescens* L., *Euonymus atropurpureus* Jacq., *Ascyrum stans* Michx., *Rhododendron catawbiense* Michx., *Fothergilla major* Lodd., *Robinia nanna* (Ell.) Spach., *Gaultheria procumbens* L., *Gaylussacia baccata* var. *glaucocarpa* (Robinson) Mackenzie, and *Symplocos tinctoria* (L.) L'Her.

On the Sexuality of the Filament of Spirogyra: BERT CUNNINGHAM.

If zygotes occur in both filaments as the result of scalariform conjugation, the filament is said to be bisexual. This condition is called cross conjugation. All cases reported thus far have been considered as abnormalities on account of their rareness. The writer collected a species in cross conjugation in April, 1915. It has been tentatively identified as *S. inflata*. Professor G. S. West verifies this classification. This shows that bisexuality of the filament does occur in the genus. Bisexuality is due to retarded reduction. In scalariform conjugation reduction occurs in the zygote with the loss of three nuclei, while in lateral and cross conjugation, reduction takes place in the filament and no nuclei are lost. The essential difference between lateral and cross conjugation is that the cells may continue to divide after reduction in the latter, while they do not in the former. In this respect the filament of *Spirogyra* which cross conjugates is homologous with the sporophyte of higher plants.

The Diorites of the Chapel Hill Stock: JOHN E. SMITH.

The specimens described here were obtained along Bolin's Creek. Some were taken near the inner margin of the zone and some near the creek at the foot of Clover Hill. The primary minerals as shown by the microscope are oligoclase, hornblende, quartz, magnetite and apatite named in order of their abundance. The apatite occurs as inclusions. The oligoclase contains innumerable, minute inclusions occupying most of the area of the crystals except in the narrow marginal zone which are entirely free from them. The parallel striations are in general very narrow and very close together and in some of the zones are invisible. The order of crystallization is as follows: apatite, magnetite, hornblende, oligoclase and quartz. The secondary minerals are epidote, and a small quantity of albite. They are derived from the oligoclase, magnetite and hornblende by hydration.

The quartz decreases in amount outward from the center of the stock. The lime in the water supply of Chapel Hill is produced from this feldspar. The soils derived from the rocks of this zone constitute the Iredell series and contain little or no potash.

Physiography of the Isle of Palms (S. C.): E. OSCAR RANDOLPH.

The Isle of Palms, situated eight miles to the northeast of Charleston, and connected with that city by a trolley line, has an area of approximately 4,000 acres. This sea-captured land is about six and one fourth miles in length, and one and one fourth miles in maximum width, tapering to a decided point at the southwestern end. Physiographically this area is interesting and instructive. In shape it approximates a ham; and by local fishermen it is called "the ham."

From the mainland the island is separated by a narrow inlet that is wide and deep enough to convey local freight-, pleasure- and fishing-vessels. This back beach is subjected to no unusual geological agencies except tidal work. The front beach is subjected to wave, tidal, wind and littoral current agencies. As a result, frequent shore-line configurations are effected. The writer made a number of instructive observations relative to immediate changes of epicontinental shelving between the points of high and low tide respectively.

Two well-defined sand dune ridges traverse the island lengthwise. Physiographically, incipient, migratory, temporary and fixed dunes are in evidence. Among the flora are found sand arresters and dune fixers. The front beach is continuously attacked by wind and wave action; the interdune area is likewise undergoing change under the influence of wind-trough currents and animal life. The age and stability of the fixed dunes, ranging in height from twenty-five to forty feet, is realized in their supporting luxuriant palm trees.

Alternation and Parthenogenesis in Padina: JAMES J. WOLFE.

At the meeting of this academy in 1913, the writer made a preliminary report on this work. It had then been carried only to the point of demonstrating that tetraspores invariably produce male and female plants. The entire series has now been completed, showing with equal certainty that fertilized eggs produce only tetrasporic plants—thus demonstrating "alternation of generations" in *Padina*.

In view of the fact that *Padina* grows well only in localities where it normally occurs, in the experiments dealing with parthenogenesis, clean oyster shells were attached alongside those bearing unfertilized eggs to serve as controls. The results of both series were in essential respects sufficiently similar to show that all plants recovered were in both cases derived from chance reproductive bodies. Thus, it is fairly conclusively shown that unfertilized eggs, though they germinate quite freely parthenogenetically, never produce mature plants.

No abstracts have been received for the following papers:

"Friday Noon," by George W. Lay.

"Zonation in the Chapel Hill Stock," by Collier Cobb.

"*Russula xerampelina*; a Study in Variation," by H. C. Beardsley.

"Improvements in the Method of Determining the Heating Value of a Gas," by C. W. Edwards. (By title.)

"Magnetic Separation of Minerals," by Joseph Hyde Pratt.

"Insect Polyembryony," by R. W. Leiby. (Lantern.)

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E. W. GUDGER,
Secretary

SCIENCE

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MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

THE LIFE AND WORK OF CARL LUDWIG[1]

WE are gathered together as teachers and investigators to commemorate the life of a teacher of teachers and an inspirer of investigators. We represent many phases of academic activities, most of which are far removed from the special branch of science to which Ludwig devoted his life. Therefore, only a greatly condensed account of his physiological discoveries will be given, and most of this paper will be devoted to his life, and an attempt to bring out from the testimony of his old pupils and friends, the traits of character which gave him his remarkable power as a scientist, and enabled him to win the reverence and, I may say, the love, of all those who had the good fortune to work with him as students and colleagues.

Carl Frederick Wilhelm Ludwig was born in Witzenhausen, a little town on the banks of the Weser, not far from Cassel, in the electorate of Hesse, December 29, 1816. His father, an officer in the Napoleonic wars, had been compelled by wounds to give up a military career, and being in favor with the elector, was appointed Rentmeister in Hanau. Ludwig came from a race of fighters, and a deep scar on his upper lip gave evidence of his participation in student duels. He was proud of his descent, and I recall an amusing reference which he made to the fact that the Hessians had played a part in the early history of our land.

He was the second of six children, who

[1] Read before the Research Club of the University of Michigan, at the "Memorial Meeting," April 19, 1916, by Warren P. Lombard.

were carefully trained at home by a wise and affectionate mother. At the close of his school days at the Gymnasium in Hanau, he was sent to the University of Marburg, where his student days were stormy. Indeed, as a result of conflicts with the disciplinary authorities, some say because of political activities, he was forced to leave for a time. He studied at Erlangen, and spent one year at the surgical school at Bamburg, finally returning to Marburg, where he took his doctor's degree in 1839. Continuing his studies, he was appointed, in 1841, second prosector of anatomy under Ludwig Fick. The following year he was formally admitted to the faculty of the university.

Ludwig has often been incorrectly numbered one of the pupils of Johannes Müller, but Tigerstedt states that he was a finished physiologist when he first visited Berlin, and that the one of the older scientists who exerted the greatest influence on Ludwig was Ernst Heinrich Weber. Even in his old age Ludwig spoke with the greatest admiration of his predecessor in Leipzig, and could not say enough of the tremendous importance of the part played by Weber in the development of science.

In 1846 he was appointed ausserordentlich professor of comparative anatomy at Marburg, and in 1849 professor of anatomy and physiology at Zurich. It was in this year that he married Christine Endemann, who with loving care watched over him, guarding with affectionate solicitude his somewhat frail health, making possible his life-long devotion to science.

In 1855 Ludwig was called to Vienna as professor of physiology and zoology at the academy for army physicians—the Josephinum—and in 1865 he succeeded Ernst Heinrich Weber in Leipzig, receiving the title of professor of physiology and director of the physiological institute, which was about to be constructed.

A list of the honors which have been conferred upon a man is of interest as an indication of the way he was regarded by his contemporaries. Ludwig's titles in the register of the University of Leipzig read as follows: Ehrendoctor der Philosophie der Universität Leipzig, Königlich sächsischer Geheimer Rath, Comthur I Klasse des Königl. sächsischen Albrechtsordens mit dem Stern, Comthur 2. Klasse des Königl. sachsischen Verdienstordens, Ritter des Königl. preussischen Ordens pour le mérite unde des Königl. bayerischen Maximilianordens für Wissenschaft und Kunst, Inhaber der Copley Medal of the London Royal Society, Commandeur I Klasse des Königl. schwedischen Nordsternordens, und Ehrenbürger der Stadt Leipzig (this last honor being given on the occasion of the celebration of his fiftieth Doctor's jubilee). In addition he was a member of the Akademien der Wissenschaften in Berlin, Wien, München, Paris, Petersburg, Rome, Turin, Stockholm, Upsala, et cetera.

The period when Ludwig was entering upon his physiological work was one of unrest in medical as well as political thought. Modern biological conceptions can be said to date from that time. The greatest physiologists of the day in Germany, Johannes Müller and Liebig, while recognizing that living beings are influenced by the physical and chemical forces which govern inorganic things, assumed the existence of some mysterious force within the bodies of animals and men, which caused life processes to take a different course from those occurring in inanimate objects. Only death released the atoms from this mysterious influence and permitted them to act as they did outside of living organisms.

This vitalistic doctrine was combated and for a time at least overthrown by the scientific work of the pupils of Johannes

Müller, Helmholtz, Du Bois-Reymond and Brücke and by Ludwig.

Helmholtz, recognizing the limitations set by the existing chemical and physical knowledge, devoted himself only to those branches of science which seemed capable of exact chemical and physical explanation; Du Bois-Reymond contented himself with the study of the narrow field of electrical phenomena of living organisms, and did more than any one else to show that physiological problems are capable of being handled with the same precision as the purely physical; Ludwig, with characteristic fearlessness and enthusiasm, attacked problem after problem, striving to find out how many of the subtle processes of life were susceptible of a mechanical explanation.

Ludwig's "Lehrbuch der Physiologie des Menschen," the first edition of which came out from 1852–1856, and the second, from 1858–1861, was dedicated to his friends, Brücke, in Vienna, Du Bois-Reymond, in Berlin, and Helmholtz, in Bonn. The writer's point of view was diametrically opposed to that of his predecessors. Throughout the book the explanation for vital processes is sought in pure mechanics, in the widest sense. He wrote in the introduction:

> The problem of scientific physiology is to determine the functions of the animal body and deduce them as a necessity from its elementary conditions.
>
> Whenever the body of an animal is subdivided to its ultimate parts, one always finally arrives at a limited number of chemical atoms, and upon phenomena which are explainable on the assumption of a light ether and electricity. One draws the conclusion in harmony with this observation, that all forms of activity arising in the animal body must be a result of the simple attractions and repulsions which would be observed on the coming together of those elementary objects. This conclusion would be unassailable, if it were possible to show with mathematical accuracy, that the elementary conditions were so arranged in the animal body with respect to direction, time and quantity, that all of the phenomena of living and dead organisms must necessarily flow from their interaction.
>
> This conception, as is well known, is not the traditional; it is the one among the newer, which, as especially opposed to the vitalistic, has been named the physical. The view, aside from all details, finds its justification in the irrefutable demand of logic, that a cause shall underlie every result, and further in the soundest rule of every experimental science, that one draws only on absolutely necessary grounds of explanation.

Du Bois-Reymond toward the end of the year 1848 said:

> The belief in a vital force, like the other dogmas, depends less on scientific conviction than the need of a soul to certain organizations; that is why this belief, like that of the dogmas, can not be rooted out.

The slowness with which the new view was accepted is demonstrated by the fact stated by Kronecker, that Claude Bernard, only towards the end of his life, 1876, made the definite statement:

> Que les conditions de manifestations de la vie sont purement physico-chemique et ne diffèrent par sous ce rapport des conditions de tous les autres phénomènes de la nature.

In 1895 Mosso wrote from Italy:

> After a short truce during which vitalism appeared to be abandoned, we see it born again under another form. Literature and art bear witness to the reaction which produces itself, and on all sides one detects the breath of mysticism which invades the mind. The school of the neo-vitalists has already conquered the pulpit, and many fear that it will stifle the spirit of true science, as it has done in the Catholic universities.

Tigerstedt, one of Ludwig's favorite pupils, who has become one of the best known of the physiologists of our time, and who, although a Finn, was unanimously chosen as president of the International Congress of Physiologists, which was to have met in Paris this autumn, gives perhaps the best expression of the attitude of the present-day physiologists:

In the newest physiology there is noticeable an undercurrent which offers as its conception with always less reservation that not even the simplest life processes, as for example respiratory gas exchange and lymph formation, can be explained wholly on a physico-chemical basis, but that they chiefly depend on vital processes in the cells. . . . But this new vitalism distinguishes itself in a very important point from the old. It does not assume the existence of a peculiar, mystic vital force, and does not break away from the fundamental view, which the last fifty years have made the unalterable possession of physiology, with the truth that the principle of the conservation of energy applies to living as well as to dead nature. This being so, it is of relatively secondary importance whether the complicated processes, which take place in living beings, can or can not be explained by the physics and chemistry of our time. In any case they follow definite laws, and are not called out by a whimsical power, which can at the one instant be indefinitely strong and at the next nul. So if we say that this or that process is attributable to cell activity, that signifies nothing else than that our present physical and chemical knowledge is still insufficient to completely explain these processes, and that the right explanation will possibly only be found if the forces working within the cell lie more clearly in the sight of the experimenter.

And if it were true that many theories which Ludwig expressed had lost some of the likelihood which they formerly seemed to have, what has that to do with their importance for our science? In all natural science we meet the observation that theories have only a limited life, that one theory after a shorter or a longer time must give place to another, which can indicate more completely or better than its predecessor the character of the phenomena which it should explain. A theory is then good, and has an importance in the development of science, if it is of such a kind that it leads to new investigations, based on direct observation of nature, through which science wins in breadth and depth. If through it such facts shall be discovered as are not in harmony with the theory, which they have, nevertheless, to thank for their discovery, then the theory falls. But it falls with honor, for it has led to the discovery of new truths, and has constructed an important link in the development of science. Whatever the fate of Ludwig's theoretical views, we can surely say that they have greatly enriched science, and so bear the stamp that is the sign of good theories.

It is interesting to read the estimation of Ludwig's character and his methods of work by another great investigator, Wilhelm His, the great Leipzig anatomist:

Ludwig's weapons of research were an uncommon sharpness of analysis of living processes under observation, an always clear formulation of the question, and an absolute reliability of the method of attack. It was of great importance for his career that he was a schooled anatomist and controlled microscopical technique to a remarkable degree. From his anatomical knowledge came his consummate and careful technique as an experimenter on living animals, in which only Magendie and Claude Bernard are to be compared with him. Moreover, he had at his command a shrewd intuition, without which the clearest thinker is often powerless in the investigation of living processes. Nature does not always allow herself to be conquered by logic, her ways are frequently hidden, and she reveals herself only to him who has sharpened his sight for insignificant traces, by persistent, faithful observation. Ludwig had to a high degree a love for personal observation, and a successful preparation or a striking experiment was for him an esthetic pleasure. He placed direct perception, in the study of living nature, far above working with abstract conceptions.

As has been said, when Ludwig was appointed to the chair of physiology in Leipzig his first task was the planning of a physiological institute. This institute was the seat of Ludwig's labors for nearly thirty years; it saw the development of many of the greatest physiologists of the past five decades; it was the birthplace of discoveries which have been of inestimable value to medical thought; and the remarkable success of the ideals and methods which he, as director, put into practise, caused it to become the model for many others. The plan is a witness of his breadth of view, and the recognition that the problems of physiology can be solved only through a knowledge of the structure of the parts involved, and a study of both the physical and chemical changes occurring within them, and that under ideal conditions, all of these forms of work should go

on side by side. The building had the form of a capital E. The main portion was arranged and equipped for the study of physiological processes from the physical side, one wing was devoted to histological work, the other, to physiological chemistry. The lecture room, closely connected to the main part of the building, occupied the space between the wings. Above the laboratories, but completely separated from them, were the dwelling rooms of the professor and his family.

Ludwig reserved a well-lighted corner room for his private office. The door which communicated with the main laboratory was, however, very rarely closed, and his room was the passageway to the small adjoining room which contained the library, to which those working with him had access at all times. The books, largely journals, were free to the use of all, and could be even taken home, the only restriction being that the borrower should enter the book and his name.

His says that Ludwig's customary greeting, when His entered his chamber was, "Was giebtes neues?" The news for which he thirsted was not the gossip of the day, but suggestion for a new scientific problem, a new method of attack, the recital of some successful piece of research work.

When the London Royal Society presented the Copley medal to Ludwig, it was given not so much because of the important investigations which had appeared under his name, as because of the vast number of researches which he had conducted with the aid of his pupils, but in which his name failed to appear, and the still greater number, which were the result of the inspiration which those who had worked with him carried away, often to distant lands, and in their turn imparted to others.

Ludwig was truly remarkable for his ability to utilize the work of the young and inexperienced. A great school of physiology developed under him at Leipzig, with an activity with which only Liebig's chemical laboratory in Giessen could be compared. As many as nine or ten men, from almost as many different countries, might be found working in his institute at the same time, and this international circle lived, as Kronecker said, under the influence of the refined, kindly knower of men, in perfect harmony.[2]

Why was Ludwig's laboratory always full when the other German physiological laboratories had only one or two workers? The instant one entered it, he felt that it was a place where things worth doing were being done. Ludwig's enthusiasm pervaded it, and it was an intense pleasure to work in the stimulating atmosphere. I can recall Ludwig's joyous shout, as he called all who could leave their work to come and witness some physiological process revealing itself in its true light for the first time, or some unusually suggestive histological or anatomical preparation. And then came one of those delightful talks, leading us forward to the border land of science, and giving us glimpses into that fascinating, mysterious land—the unknown. I must admit that at such times, Ludwig's active mind sometimes, leaping over lines of thought which were new to us, often out-

[2] The following Americans were pupils of Ludwig: Gerau, of New York, 1845–46; Bowditch, of Boston, the first and best known of American physiologists, for many years professor at the Harvard Medical School, 1869–71; Minot, of Boston, one of the foremost of American embryologists, also many years professor at the Harvard Medical School, 1873–74; Abel, now professor of pharmacology at Johns Hopkins and formerly filling the chair in this university, who has a very high reputation, 1884; Mall, one of our graduates, now professor at Johns Hopkins, and probably the strongest anatomist in this country, 1885; Lee, professor of physiology at the medical department of Columbia, New York, who has done excellent work, 1886.

stripped his listeners. I thought that, in my own case, it was my incomplete knowledge of the language that was at fault, but I remember that von Frey, who was then docent in physiology, said that frequently he could not follow Ludwig.

Another thing that drew men from distant lands to his laboratory was the fact that it was well known that he never made use of his students for his own immediate glory, and that the researches which he inspired, and even those in which he did the most difficult part of the experimentation, were at all times treated as the personal investigations of those who worked with him, and were published under their names. As evidence of his unheard-of self-denial, Tigerstedt offers his own case. Having carried through a piece of work at Ludwig's suggestion, he sent him the manuscript from Stockholm for his criticism. The only correction which he made was to strike out the words, "Stetiger Beihülfe vom Herrn professor Ludwig."

It has often been said that Ludwig was absolutely unselfish in the lavish way in which he gave his ideas to others. He had so many ideas that he could well afford to be generous; he loved his science and rejoiced in the scientific achievements of his pupils; he was, moreover, worldly wise, in the best sense.

> Oh, if we draw a circle premature,
> Heedless of far gain,
> Greedy for quick returns of profit, sure
> Bad is our bargain.

The wonderful richness of the uninterrupted series of papers, published from his laboratory during the 56 years of his activity, was only made possible by his skilful division of labor, and his capacity to estimate the abilities and tastes of those who worked with him. Each man had his own clearly defined problem, and the problems were as distinct as the men. It was remarkable how many different forms of research he could supervise at the same time and keep them all clearly in mind. When I was working with him there were Wooldrich, who was studying the effect of stimulating special parts of the heart of the dog; Stolnikow, the rate of flow of the blood; Tigerstedt, the latent period of muscle; von Frey and Grubler, metabolism of isolated muscle when at rest and in action; Bohr, the way gases enter and leave the blood in the lung; myself, the method of spread of reflex processes in the spinal cord; and Miss Smith, who was working on a histological subject with Gaule, and others, working under Drechsel, on problems in physiological chemistry, among whom was Abel, now professor of pharmacology at Johns Hopkins.

You might be interested to know his daily routine. Every morning he visited the tables of the different men and discussed with them the next step to be taken, often appointing the hour when he would take part in the research with them (and the appointment was always punctually kept); or he would take them into his private room and critically discuss the methods employed, making suggestions as to the direction in which new and more effective methods could be sought, carefully go over the curves and other data already obtained and the inferences to be drawn from them. This was not done offhand, for each night when he left the laboratory he carried to his rooms above, records and protocols of investigations in progress, for careful study.

An hour or more was devoted to the preparation of his lectures, which were given at four o'clock and were richly illustrated with experiments. In the preparation of the experiments he was assisted by the mechanic of the laboratory, Salfamoser, who had come with him from Vienna to Leipzig. No account of Ludwig and

his laboratory would be complete without mention of Salfamoser. He had worked with Ludwig so long that he was thoroughly familiar with the routine of the laboratory and even the most complicated experimental methods. He was the first instructor of many a pupil in the technique of the operations which he had to perform, as well as the use of the apparatus. When Ludwig himself took part in operative experiments, Salfamoser often acted as his assistant, and, not infrequently, to the disgust of Ludwig, as his adviser. I can recall seeing Ludwig draw himself up and say to Salfamoser, "Who is the professor here, you or I?" "Oh, you are Herr Professor; nevertheless, I am right." Salfamoser was devoted to Ludwig, and Ludwig, fully recognizing his faithfulness and his ability, depended on him as one depends on his hands.

Ludwig's lectures were addressed to the most advanced of his students, and were attended by all of those working in the laboratory. The beginner had a hard time, and almost all of the ordinary students attended the course twice before presenting themselves for examination. Ludwig entered into his lectures with the same earnestness and vigor that characterized all of his activities. I attended, if I recall rightly, his forty-seventh course, and I never saw him enter the lecture-room that he did not change color. He did not know what it was to be blasé.

After his lecture he frequently went for a walk unless he had to attend the examination of some student, a task which he loathed. There was no work done in the laboratory Saturday afternoon, when it was left to the mercy of the scrubwomen; and no work was done on Sunday.

His intense interest in the problems that he was studying was infectious; his enthusiasm imparted itself to his pupils, and aroused all of their ingenuity and their best powers of observation and thought. Ludwig's untiring energy in the hunt, inspired the pupil with an unknown constancy of effort, the problem possessed him day and night, and when he began to dream of it the light began to dawn.

My own case must have found its counterpart in that of many others. I entered his laboratory knowing physiology only as I had learned it in the lecture-room. He assigned my problem, started me upon the method which at the outset seemed the most promising, and followed each advance with close attention. When I reported that I had found something new, he would ask me to show my records and prove to him that I had really found what I supposed. Even when the facts reported had long been known, no cold water was thrown on my enthusiasm, and I was allowed to have the supreme pleasure of having made, as I truly had, a discovery. And so he led me on, often helping me with the experiments themselves, and when, at the end of a year and a half, I had brought my results together and written the first draft of my paper in English, he put it into German, practically rewriting it. I shall never forget my feeling of embarrassment, as I said to him that I felt that I had no right to let the paper appear under my name, for I had been only his hands; that it was really his work and not mine. "It is all right," he said, "it has been your work." Then he added, "But if you never do anything else, it will be thought that you did not do this."

Ludwig did not know how to fail: once started on a trail he would follow it for years. He once said to me, "Never let nature get the better of you; if you do, she will take advantage of you next time."

He would never permit slovenly work. I remember one day he asked me to make

an iron hook which we needed. I bent one which I thought would do, but without criticizing it directly, he proceeded, while discussing the work, to painstakingly rebend it, until it exactly fitted our need. I carried that hook in my pocket for years, and although I finally lost it, the lesson has clung.

He taught his students independence. On one occasion when I offered to help him tie a ligature in a difficult place, he said with a merry smile, "No, no; if I let you help me now, you will want me to come and help you the next time you have a knot to tie."

Kronecker said of him:

> He understood how to instil his ideas so that those working under him often thought them their own. But he wished to bring out his own characteristic methods of expression when it came to the publication of the work, and every expert was able to recognize in the papers coming from the Leipzig institute the hidden thoughtful exposition of the master.

Von Frey admirably described his characteristics when he wrote,

> The steadfastness with which Ludwig clung to the complete control of the direction of the work, might suggest a form of military discipline in the laboratory. This certainly did not apply to the personal relations which existed. Nevertheless, such a comparison is not without value for an understanding of the exceptional results of his teaching. Among other qualities Ludwig possessed those which could be described as marked military virtues: boldness of design, tenacious perseverance in execution, presence of mind and high personal courage, an unusual talent for organization bound up with a knowledge of men, which knew how to put every force in its right place, strict discipline, frankness and heartiness in personal relations, indefatigableness in work, together with exemplary orderliness and punctuality.

With the love which our master inspired, there developed in the laboratory an esprit de corps, so that to have worked with him was a password that gave free entrance to the laboratory and the friendship of every other who had been his pupil.

Ludwig's old students, in token of their esteem, on the occasion of his twenty-fifth anniversary as ordentlicher professor, presented him with a Festschrift. In this was a list of his pupils up to that time, which numbered 142. In the twenty years that followed, a hundred others worked with him.

Many of Ludwig's researches were purely anatomical, or the physiological problems were handled chiefly on an anatomical basis. One thinks of the structure of the heart and its relation to its change of form, and of his attempts to bring the structure and course of the blood vessels in various organs into the explanation of their function. The excellent methods of injection of blood vessels developed in his laboratory, made it possible for him to study the circulation in many organs as it had never been done before, *e. g.*, in the eye, ear drum, liver, lymph glands, corpora cavernosa, intestines, muscle, ear-labyrinth, larynx, skin. Especially worthy of mention is the natural injection of the lymph spaces, by means of which Schweiger-Seidel and Ludwig studied the lymphatics of the pleura, the central tendon of the diaphragm, the retina and the liver.

As far as is known, his first physiological research was his habilitationsschrift, "Beiträge zur Mechanismus der Harnsecretion," published in Marburg, 1842, when he was twenty-five years old. In this work on secretion by the kidney, he developed the first physical theory of secretion of a gland. He deduced the method of the secretion of the urine from the structure of the kidney, and the physical forces which he thought must necessarily control them.

This work made him desire to know more concerning the action of physical forces on the passage of fluids through animal membranes, and led to important researches on

diffusion and osmosis. The exactness of the results were recognized by Ostwald.

He never lost interest in the original problem and a number of his students were assigned various phases of it during the succeeding years. An evidence of his open-mindedness is the fact that he was not disturbed by results which seemed to oppose his original view.

How Ludwig would have reveled in the clever technique displayed in the models and drawings of the kidney tubules, which have been developed in this laboratory by Dr. Huber.

Although emphasizing the important part played by blood pressure in the secretion of the urine, he proved experimentally that the pressure of the blood does not explain the secretion of the saliva, and his epoch-making discoveries with regard to the activities of the salivary glands began a new era in our knowledge of secretion processes. He proved that gland cells, like muscles, are capable of being awakened to activity by nerves, and become the seat of chemical changes, accompanied with the liberation of heat and the giving off of materials differing from those found in the blood.

Not less important were Ludwig's investigations of the interchange of oxygen and carbon dioxide gas between the blood and the tissues, and the blood and the air in the lungs. The blood-gas-pump devised by Ludwig and Setchenow in 1859, a new application of the Torricelli vacuum, proved the key to unlock many difficult problems. There followed many investigations by his pupils Schöffer, Holmgren, Preyer, Alexander Schmidt, giving the first measurements of the tension of the gases of the blood, and by Worm-Muller and Donders on the conditions which determine the tension.

Ludwig opened up still another line of work, the chemical changes occurring within special organs, when he found that it was possible to separate organs from the general circulation, and to study their metabolism by keeping them alive by artificially circulating defibrinated blood through them; *e. g.*, the heart of the frog was thus kept alive and acting for many days, and the effect of temperature, foods and drugs upon its activity were examined.

His studies into the formation of lymph, and the cause of its movement in the lymphatics, were of great value. According to Ludwig the plasma of the blood filters through the walls of the blood vessels, and so food materials are supplied to the various tissues. It is also the pressure of the blood which is the principal cause of the movement of the lymph stream. Where this is not sufficient, as in the case of the large cavities of the body, there are special pumping arrangements provided: in the abdomen and in the pleural cavities it is the respiratory movements of the diaphragm and of the chest walls which are responsible for the flow.

The conditions which determine the circulation of the blood always aroused his keenest interest, and it was because of his desire to grasp their significance that he was led to what has proved the most fruitful of his discoveries, the graphic method of recording physiological movements. In 1846, while still in Marburg, he studied the relation which exists between the movements of respiration and the pressure of the blood. He connected a U-shaped manometer tube partly filled with mercury, with an artery, but the movements of the column of mercury were so rapid and complex that the eye failed to retain them. It was then that he conceived the idea of recording the changes in pressure, and devised the kymographion. Let me quote his own words in his paper, "Beiträgen zur Kent-

niss des Einflusses der Respirationsbewegungen auf den Blut lauf in Arteriensystems," published in *Müller's Archiv*, 1847. "To obtain reliable figures under all circumstances by means of it (referring to Poiseulle's mercury manometer), and at the same time, time determinations for the duration and course of the different pressures, one places a rod-like float on the mercury, puts on the upper end a writing-point, and lets it draw the variations in pressure on a surface, which moves by the pointer with a constant velocity. In this way one obtains curves, the height of which is a measure of the blood pressure, and the width an indication of the time." Ludwig recorded the movements of the respiration and the oscillations of the blood pressure on the same paper simultaneously, and thus obtained curves which made possible an accurate comparison of the two series of events.

Although the graphic method was known at the beginning of the century to meteorologists and physicists (especially through the work of Thomas Young), it had been neglected and was carried again into physics and meteorology after the discovery of the kymographion. It has become, with its many modifications, an indispensable aid to the physiologist, pharmacologist, pathologist, clinician, and to experimental biologists and botanists. His pupil Angelo Mosso, the celebrated Italian physiologist, showed me the original tracing when I visited his laboratory in Turin. There is inscribed upon it the date, December 12, 1846, and notes concerning the experiment. It was the first time that the heart and respiration had spoken in their own language, and Ludwig in presenting it to Mosso wrote on the back—"I give to my friend Mosso for his collection, this first stammering of the heart and of the chest."

This was followed by researches into the structure and changes in form of the beating heart, which served to explain the true significance of the apex beat. He also did much to increase our knowledge of the cause of the first sound of the heart. All of these studies on the mechanics of the circulation naturally led Ludwig to a consideration of the means by which it is regulated, and so to a study of the nerves which act on the circulatory system.

The Weber brothers had discovered the effect of the vagus nerve to inhibit the heart. Schmiederberg, under Ludwig's guidance, 1866, discovered the accelerator nerve of the heart of the frog and of the dog, and in 1883, Wooldrich found centrifugal fibers to the heart of the dog, which altered the blood pressure without changing the rate of the beat. Bowditch, the best known of American physiologists, Luciani and Stienon, studied the effects of electrical excitations on the heart muscle, and ascertained a number of facts of theoretical importance to heart and muscle physiology.

Henle had observed the muscles in the walls of the blood vessels and Claude Bernard the existence of nerves which cause the constriction of certain blood vessels. It was left for Ludwig and Thiery to point out, 1863, the importance of these nerves in maintaining the tonus of the blood vessels, and consequently the blood pressure. Cutting the spinal cord was found to cause a fall, and exciting it a rise of blood pressure, without any change in the rate of the heart. They saw the vessels of the abdomen contract, and thought that the nerves ran in the splanchnic, a fact which Ludwig and Cyon proved in 1866. Moreover, during these latter experiments a nerve was found which ran from the heart to the medulla, the depressor nerve, which acts reflexly from the heart to dilate the blood vessels, and which protects the heart

from too great arterial blood pressure. Later, Ludwig and his pupils established more definitely the seat of the vaso-motor centers, and showed that the veins as well as the arteries of the portal system are under the control of nerves. Mall, now at Johns Hopkins, who worked with Ludwig in 1885, established this last fact.

It was Ludwig who started Mosso on the development of the plethysmographic method, by which the volume changes of organs under the influence of the alterations of the blood supply have been studied by many investigators, *e. g.,* Edmunds has found it of great value in work which he has been doing in the past years.

Ludwig's cleverness in inventing instruments required for his investigations is to be seen in the Stromuhr, by the use of which he was able to succeed where others had failed, and to measure the rate of the flow of the blood stream. By means of this he measured the rate of the output from the heart under varying conditions, and the amount of blood flowing through special organs when at rest and in action.

He was always deeply interested in reflex processes, and many experiments were carried on in his laboratory on the paths taken by nervous impulses along the white matter of the cord, summation processes, and the effect of local excitations and poisons. In addition, he caused many researches to be made on the special senses, sight, hearing and taste.

Investigations of a chemical nature were also made at his instigation, and von Frey has pointed out the difficulties which he must have encountered in directing such work, lying as it did outside of the fields with which he was most conversant. From the time that Ludwig and Alexander Schmidt found that easily oxidizable substances pass from the tissues into the blood, many such intermediate products were discovered in the chemical side of the laboratory, and their distribution through the body followed. Cloetta discovered the presence of inosit, uric acid, etc., in the animal body; calcium and phosphoric acid in the blood were measured; the lessening of glycogen in the "uberlebender" liver was noted; and the origin of jaundice studied. The method by which fats are absorbed, the streaming of fat in the lymphatics, the constitution and the fate of the fats entering the blood, all received attention. The digestion and absorption of proteins and sugars, and the changes which they undergo after entering the body were investigated, the structure of albuminous bodies being made the subject of special study by Drechsel.

An interesting discovery was made while the method of absorption of the digestion products of protein was being studied, namely, that albumoses if introduced directly into the blood act as poisons and deprive the blood of its power to coagulate. This observation gave a new impulse to the study of coagulation, and of the formed elements of the blood.

I am conscious of the incompleteness of this hasty summary of the work of Ludwig and his pupils.

Ludwig, himself, was deeply impressed with what had been accomplished, and the wide field of knowledge which had been opened up to man. I remember that he said the last time that I saw him, "What a pity that one must die just as it begins to be so interesting."

I can not close this paper without a few words concerning Ludwig's private life. He was no lover of forms and ceremonies, and counted of little worth the honors conferred by the so-called "great." I chanced to be present when a student called in dress coat and white gloves at the formal noon hour, as was the custom, to ask his

permission to enrole in his course of lectures. When the student addressed him as Herr geheimer Rath, Ludwig straightened up and corrected him, "Ich bin Professor."

In spite of his simple, genial manner, he had an innate dignity which always inspired respect. I can not imagine any one taking a liberty with him, certainly not a second time, for he could be cuttingly severe when he chose.

He was not only thoughtful and considerate of others, but his tender heart made him, although of necessity a vivisector, always careful to avoid the infliction of unnecessary pain. He saw to it that all experimentation on animals in his laboratory was performed in such a way that the suffering incurred should be the least possible. He was president of the Leipzig Society for the Prevention of Cruelty to Animals for twenty years, and did much to develop in the community a recognition of man's duty towards the animals dependent on him. The fact that he held this position for so long, shows how thoroughly this side of his character was recognized by his fellow citizens.

In his young days he was an active polemiker, and in that connection could use right hard words, but one never noticed in his controversies anything that pointed to an overestimation of self; the contest was simply the expression of his inner conviction that the way that the new physiology had chosen was the right way, and that one must vigorously fight the methods of dilettanteism, which, without regarding the true content of the question at hand, would escape the difficulties, to reach results which at first glance were striking.

Every new advance which promised to open the doors of nature's secrets, regardless of where and by whom they were made, was greeted not merely with warmth, but with enthusiasm. M. Chauveau, when president of the Société de Biologie of Paris, referring at one of its meetings to the loss which science had suffered in Ludwig's death, said, "Ludwig, du rest, etait animé du sentiments de l'equité porté au plus haut dégré; il n'a jamais ménagé l'expression de son admiration à ceux de nos compatriotes qui en étaient dignes."

Ludwig's interests were not merely scientific. He possessed a remarkable fund of information on the greatest variety of subjects, and whether he spoke of music, art, industrial and political conditions in other lands, of science or philosophy, his point of view was always original and suggestive. He had a keen sense of humor, and in the midst of a conversation of grave interest he would introduce an amusing story which would illustrate the point under consideration without breaking the thread of thought. An admirable storyteller, he rarely told a story for the story's sake; gifted beyond most men as a speaker, he was a good listener; in short he had the ability, possessed by so few, of leading a conversation so as to bring out the best from others.

Much of his power over his pupils was based upon his unaffected regard for them as individuals. He entered into their lives as only a friend can do, and continued his interest in them and their work long after they had left the institute. He wrote a charming letter, and found the time to answer his old pupils when, working under unsympathetic conditions, they turned to him for advice and new inspiration. I hold in my hand a photograph which I value greatly, and which bears a characteristic inscription: "Could I but spring and swim like the third in our league, I would soon croak 'Good morning' to you and your dear wife in New York. Oh they were good days. Your former teacher." They were good days.

In February, 1895, two months before he

died, when he was seventy-eight years old, Professor Ludwig wrote to me to say that he would take into his laboratory a young American whom I had recommended. Beginning the letter with a charming, fanciful sketch of the way my new house must look and the wish that he might be there with us, he ran into a soberer vein and wrote:

Destiny has conferred on us professors the favor of helping the responsive heart of youth to find the right path. In the seemingly insignificant vocation of the schoolmaster there is enclosed a high, blessed calling. I know no higher. In its fulfilment you will be the happier the more you yourself grow in knowledge and power of thought, the more you endeavor to be suited to the profession. How glad I am of your present and future happiness.

Ludwig died in his seventy-ninth year, in Leipzig, April 27, 1895. His wife wrote us:

Our daughter had come to us to help care for her father, and we were both by him day and night. Seven weeks he lay sick, but his mind was always clear. Only a few days before his death his thoughts were busied with a paper which he wished to write on his dead friend Helmholtz. On the last evening he still asked us about many things in which he was interested, then complained of great fatigue and so softly slept. The hastily called physician could only tell us that a sudden heart failure had quickly and painlessly ended his life.

No better words can be spoken at the end of an account of Ludwig's life, than those which he used at the close of his Gedächtnissrede for Ernst Heinrich Weber:

Now that he has departed from us, he has left us a rich heritage, but inestimable good has sunk into the grave with him. The one on whom his soulful eyes rested, who listened to the flow of his thoughtful words, who felt the pressure of his hand, will always long for him. Yet not only the friend, each one who in life and in science came in contact with his power, will mourn the death of a man, in whom were mingled in complete harmony, a spirit as clear as his and a nature of such richness.

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ANIMAL LIFE AS AN ASSET OF NATIONAL PARKS[1]

The argument most frequently urged in favor of national parks is that they provide on a large scale for the protection of forest areas, and thereby ensure the transmission of a maximum water supply from the wooded tracts to the needy lands below. Attention has also been called to their value as refuges for wild life—particularly where the animals to be conserved are useful for game or food. The strict protection they afford enables the birds and mammals within their boundaries to reproduce at a maximum rate, and the surplus thus created, spreading outwards into adjacent unprotected areas, helps to make up for the depletion caused there by excessive hunting. The points mentioned above are fairly obvious. But national parks have other less generally recognized advantages, and among these we consider their potential uses as places for recreation and for the study of natural history, especially worthy of notice. We will here lay particular emphasis on their recreative value because this phase seems to have hitherto been treated only in a cursory way, and with an air of hesitancy, as if it were hardly deserving of practical consideration.

The term recreation is currently applied to any temporary change of occupation that calls vigorously into play latent or seldom used faculties of the mind and body. It is the purpose of this change to restore to the human organs the normal balance which special or artificial conditions of life disturb. As physiologists have long recognized, the interdependence of the various bodily functions is such that the neglect of one is bound to have its effect on the others, and complete health can only be attained when every function is given its adequate share of exercise. In view of this fact

[1] Contribution from the Museum of Vertebrate Zoology of the University of California.

and of the general character of urban life at present, it would seem that the type of recreation most urgently needed by the majority of people to-day is to be found in the open country. The relatively abrupt changes coincident with modern civilization have seriously interfered with the fine adjustments acquired by the human body in the course of long ages; and the modern business man, who may be regarded as the final and typical product of these changes, can now obtain rest in its fullest sense only by resorting for several weeks in the year to the open country or mountains. There he may find entire relief from the nerve-racking drive of city life, and be brought once more into contact with primitive conditions. There he may have an opportunity of reawakening his dormant faculties and of "resetting" his physical "tone," by effecting a readjustment of physiological interrelations. One of the greatest needs of city dwelling people is to develop objective interests; "to get out of themselves," as the phrase goes; and a frequently effectual means to this end is a keen interest in outdoor things, encouraging, as it must, a healthy manner of living, an unconfined habit of observation, and a mood unaffected by the nervous tension so peculiar to town life.

If this be true, it follows that the best recreative elements in nature are those which most infallibly tend to revive our atrophied faculties and instincts. Among them the following are important. First: either perfect quiet, or an absence of all save primitive and natural sounds, such as those caused by the wind in the trees, by running or falling water, or by singing birds. Second: landscapes that relieve the eyes from close work by offering distant views, quiet harmonies of color, and a quiescent atmosphere, varied by occasional touches of movement in such objects as running or falling water, scurrying squirrels, or birds in flight. Third: accessible mountains, which encourage climbing and allow the visitor to combine the exhilaration of overcoming obstacles with the physical exercise attending the woodsman's mode of travel. Fourth: natural phenomena that make a purely intellectual or esthetic appeal, as do the conflicts between the great insentient forces of nature, the processes of geological upbuilding and destruction, the intimate inter-relations of plants and animals, and the contentions for mastery that are forever recurring throughout the whole realm of living things. We believe the last, the mental appeal, to be the element of greatest recreative value in nature, but the other three are only of slightly less importance.

The question may now be raised: "Can national parks meet these requirements any more fully than other uncultivated areas?" With the country in its present half developed state the objection has a certain degree of force. In this era one is inclined to think of the unprotected wilds as the silent, virginal and unspoiled regions of the earth, and to regard national parks as comparatively well-peopled areas where plants and animals are subjected to artificial restrictions. To a limited extent, and for the moment, this impression is a true one. But the objection will have less force in the course of a few years, and none whatever if by that time the full recreative possibilities of the parks have been realized. For the commercial exploitation of nature that is now going on so rapidly elsewhere, is daily making the conditions we have described harder to seek, and is confining them more and more closely to the park areas, where the administrators should be taking measures to propagate and conserve them. By this we do not mean that the parks should in any way be conventionalized or transformed. On the contrary, it is their chief function to prevent just that disfigurement of the face of nature by industrial machinery which is being carried on at such a disastrous rate in other localities. We mean rather that the ideal recreative conditions now to be found in them should be preserved, that all factors disturbing to these conditions should be excluded, and that the artificial elements required for the practical work of administration should be disguised or beautified past offense.

Let us, however, take up these points in greater precision and detail. The first neces-

sity in adapting the parks for recreative purposes is to preserve natural conditions. In this respect a national and a city park are wholly different. A city park is of necessity artificial, in the beginning at least when the landscape is planned and laid out; but a national park is at its inception entirely natural, and is generally thereafter kept fairly immune from human interference. Herein lies the feature of supreme value in national parks: they furnish samples of the earth as it was before the advent of the white man. Accordingly, they should be left in their pristine condition as far as is compatible with the convenience of visitors. All necessary roads, trails, hotels and camps should be rendered inconspicuous, or, better still, invisible from the natural points of vantage in the parks. Another reason for retaining primitive conditions is that natural scenery unmarred by man is one of the finest known sources of esthetic pleasure. Any attempt to modify the appearance of a national park by laying out straight roads, constructing artificial lakes, trimming trees, clearing brush, draining marshes, or other such devices, is in the worst of bad taste.

As has already been intimated, the animal life of the parks is among their best recreative assets. The birds and mammals, large and small, the butterflies and the numerous other insects, even the reptiles and amphibians, are of interest to the visitor. As a stimulant to the senses of far sight and far hearing, faculties largely or altogether neglected in the present scheme of civilization, they are of no less consequence than the scenery, the solitude and the trails. To the natural charm of the landscape they add the witchery of movement. As soon as the general surroundings lose their novelty for the observer, any moving object in the landscape will catch his eye and fix his attention. People will walk miles and climb thousands of feet to secure a good view of falling water, and this desire for movement is even more completely satisfied by the sight of animals in motion. The moving deer, passing within range of the stage-coach, rouses exclamations of surprise and delight. Eagles and pigeons in flight overhead readily claim the traveler's notice, and the smaller birds often mingle the fascination of sprightly movement with that of bright color and pleasing song. Considering the predilections of the average visitor, we should perhaps regard these last as the most indispensable creatures in the parks.

The interest of moving objects depends upon a number of elements other than movement, among which their color, and especially their size, is important. The chipmunk is more attractive than the ground squirrel, primarily because its movements are more rapid, and secondly because of its more brightly colored markings. But when movement and color are equal the average observer's selection seems to have a quantitative basis, though the rarity of the object, and its romantic or other associations affect the equation. A bear or a deer will elicit more interest than a smaller mammal, even though the latter be of a rarer species. There are exceptional cases where an animal's extreme rarity will make it of exceptional interest in spite of its inferior size, but in general the larger species are the more rare, as they are the first to disappear before human invasion. They have therefore a double claim to consideration, and measures should be taken to prevent their numbers from diminishing. After the visitor's initial curiosity has been aroused and his powers of observation developed, he may be trusted to give a closer study to the smaller species.

To realize the greatest profit, therefore, from the plant and animal life of the parks, their original balance should be maintained. No trees, whether living or dead, should be cut down, beyond those needed for building roads, or for practical elimination of danger from fire. The use of wood for fuel in power stations, or even for cooking and heating in hotels and camps, is made unnecessary by the abundant supply of water power everywhere available, and this may be utilized without marring the scenery in the slightest. Dead trees are in many respects as useful as living, and should be just as rigorously protected. The brilliant-hued woodpeckers that render such effective service in ridding the living trees of destructive insects depend in part on

dead trees for a livelihood. In these they find food during the colder months of the year, when the insects elsewhere are in great scarcity. Here, too, they excavate their nesting holes. Some of the squirrels and chipmunks also seek shelter in dead or partially dead trees. Even down timber is an essential factor in upholding the balance of animal life, for fallen and decaying logs provide homes for wild rats and mice of various kinds, and these in their turn support many carnivorous birds and mammals, such as hawks, owls, foxes and martens.

No more undergrowth should be destroyed than is absolutely necessary. To many birds and mammals thickets are protective havens into which their enemies find it difficult to penetrate. Moreover, the majority of the chapparral plants are berry-producers and give sustenance to wild pigeons, mountain quail, robins and thrushes, and to chipmunks and squirrels —this, too, at the most critical time of the year, when other kinds of food are scarce or altogether wanting. The removal of such plant growth will inevitably decrease the native animal life. If any change is to be made at all, it would, indeed, seem preferable to increase the number of indigenous berry-producing plants, especially in the vicinity of camps and buildings. This would compensate for the shrubbery lost in constructing roads and buildings, and would also serve to attract berry-eating species to the points where they might be seen by the largest number of people.

It goes almost without saying that the administration should strictly prohibit the hunting and trapping of any wild animals within the park limits. A justifiable exception may be made when specimens are required for scientific purposes by authorized representatives of public institutions, and it should be remarked in this connection that without a scientific investigation of the animal life in the parks, and an extensive collection of specimens, no thorough understanding of the conditions or of the practical problems they involve is possible. But the visiting public should be warned against injuring, and even against teasing or annoying any of the mammals, against destroying lizards and snakes (except the rattlesnake), and against disturbing the nests of birds, or their young. In the last instance a very slight disturbance will often lead to subsequent destruction. The principle underlying these suggestions is apparent. The native complement of animal life must everywhere be scrupulously guarded, particularly along the most traveled roads and paths, where the animals are likely to be observed by the greatest number of visitors. It is there that each individual animal is of highest intrinsic value from an esthetic viewpoint.

As a rule predaceous animals should be left unmolested and allowed to retain their primitive relation to the rest of the fauna, even though this may entail a considerable annual levy on the animals forming their prey. We, as naturalists, are convinced that the normal rate of reproduction among the wild non-predaceous species, such as mice and squirrels, has adjusted itself to meet a certain annual draft on their population by carnivorous enemies. Another point worth emphasizing is that many of the predatory animals, like the marten, the fisher, the fox and the golden eagle, are themselves exceedingly interesting members of the fauna, and as their number is already kept within proper limits by the available food supply, nothing is to be gained by reducing it still further. Here again may be recognized the special and intimate relations everywhere existing among the various plants and animals.

The rule that predaceous animals be safeguarded admits of occasional exceptions, according to season, place and circumstance. Coyotes and bob-cats, especially the latter, when they are numerous, are likely to kill a great many grouse, quail, rabbits and squirrels. Cooper and sharp-shinned hawks, and, to a lesser extent, blue jays, are proven menaces to small birds, and it might be advisable to reduce them in the neighborhood of camps and much-traveled roads. Caution, however, should be exercised in doing so, and no step taken to diminish the numbers of any of these predators, except on the best of grounds.

We would urge the rigid exclusion of domestic cats and dogs from national parks. Cats are the relentless enemies of small birds; they are forever on the alert, and in ninety-nine cases out of a hundred can not be trusted, however well fed they may have been at home, to let birds alone. The fact that they readily go wild, that is, quickly revert to a feral state, makes it all the more important that they be kept out of unsettled regions. To admit them would mean adding one more predator to the original fauna, and this would tend to disturb the original balance, by making the maintenance of a normal bird population difficult or impossible.

Equal vigilance should be used to exclude all non-native species from the parks, even though they be non-predaceous. In the finely adjusted balance already established between the native animal life and the food supply, there is no room for the interpolation of an additional species. If pheasants be introduced, and allowed to become established in the wild, the native quail and grouse will inevitably suffer from competition with them at the season of minimum food supply, and will be numerically reduced in consequence. The same is true of elk in competition with the native deer, and of many imported small birds in rivalry with the native varieties. In the latter connection we need only mention the well known instance of the English sparrow. Cattle and sheep are also of importance as elements hostile to natural conditions, but their destructiveness has already been emphasized by foresters.

Thus far we have laid chief stress on the importance of the national parks to recreation, and have shown the necessity, in adapting them for this purpose, of retaining the original balance in plant and animal life. But the same necessity attaches to their adaptation for another end, hardly less important than recreation, namely, research in natural history. As the settlement of the country progresses and the original aspect of nature is altered, the national parks will probably be the only areas remaining unspoiled for scientific study, and this is of the more significance when we consider how far the scientific methods of investigating nature then obtaining will be in advance of those now applied to the same study.

As a final requirement, we would urge that provision be made in every large national park for a trained resident naturalist who, as a member of the park staff, would look after the interests of the animal life of the region and aid in making it known to the public. His main duty would be to familiarize himself through intensive study with the natural conditions and interrelations of the park fauna, and to make practical recommendations for their maintenance. Plans to decrease the number of any of the predatory species would be carried out only with his sanction and under his direction. He would be able to establish and supervise local feeding places for birds and mammals during the tourist season, and could do this without in any serious degree altering natural conditions. His acquaintance with the local fauna would enable him to communicate matters of interest to the public in popularly styled illustrated leaflets and newspaper articles, on sign posts, and by lectures and demonstrations at central camps. He would help awaken people to a livelier interest in wild life, and to a healthy and intelligent curiosity about things of nature. Our experience has persuaded us that the average camper in the mountains is hungry for information about the animal life he encounters. A few suggestions are usually sufficient to make him eager to acquire his natural history at first-hand, with the result that the recreative value of his few days or weeks in the open is greatly enhanced.

We have attempted in these columns to emphasize the value of national parks as places for recreation and for scientific research, two of their uses that have been rather commonly overlooked, and to show the importance in both connections of the animal life they contain. If the reasons and instances we have adduced are valid, there is surely ample warrant for saying that the animals in the parks should be given more care and attention than

they are now receiving, and that they should be conserved and utilized to a fuller extent.

JOSEPH GRINNELL,
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THE REVIVAL OF INTEREST IN BIRD ANATOMY AT THE UNITED STATES NATIONAL MUSEUM

VERY well do I remember when the foundation was laid for a department of comparative anatomy at the United States National Museum. It took place some time along in the early eighties, when Professor Baird's splendid régime was at its height and zoological work was at its best at the Smithsonian Institution. My early papers on the osteology of birds had appeared in Hayden's Twelfth Annual of the U. S. Geological and Geographical Survey of the Territories, and, owing to a fulfilment of a promise made by the then surgeon-general of the army, I found myself in the position of curator of the department of comparative anatomy at the old Army Medical Museum on Tenth Street in Washington. Naturally, I desired to follow up my work on the osteology of birds and upon vertebrate anatomy generally. This impulse led me to obtain Professor Baird's permission to examine what the collections at the National Museum contained in the way of material for descriptive purposes, and to look into the matter of the possibility of publishing researches along such lines.

Professor Baird was a man who took an intense personal interest in the labor of all his curators, and it was his habit every day, when he could afford the time to do so, to make a round of the institution for the purpose of encouraging them in their investigations and to learn whether there was anything, in any particular case, that a curator needed to push his investigations forward. He no sooner noticed my interest in bird anatomy than he opened up the way to make it count for science, and for the advancement of work in that particular field. He immediately established a base for such operations by founding a new position for those not on the regular museum staff, but who were devoting a large share of their time to scientific investigation, with the view of publishing the results of their studies. The late distinguished Dr. Theodore Nicholas Gill and myself were the first two zoologists appointed by Professor Baird to become co-workers under him as "associates in zoology" on the staff of the institution. Shortly after this event, I undertook to examine the collection there of such material as illustrated the morphology of birds. The alcoholic collection contained many specimens of great value; but what interested me most at that time was the collection of bird skeletons. This consisted of a very remarkable, not to say heterogeneous, lot of avian skeletons, none of which were scientifically prepared. Many were roughed out; a large array of them had been cleaned up by the "sand fleas" of the seas that wash our Alaskan possessions, and, finally, not a few of them were sterna of birds *saved* by bird collectors all over the country while skinning specimens for their collections. To show how valuable some parts of the material were, I may say that, in one little pasteboard box, I found the original chicken skulls used by Charles Darwin in Volume One of his "Animals and Plants Under Domestication" (Figs. 34, 35 and 36), they evidently having been presented to the Smithsonian either by himself or by Mr. Tegetmeier. (How long they had been in that little box I do not know; at this writing they have been placed in a special case in one of the exhibition halls of the new National Museum!)

A great mass of these skeletons had been collected by our northern explorers, as Dall, Elliott, Bean, Nelson, Turner and others, and were in a fairly good condition. All this material was in "original packages," that is, in any old receptacle the collector could lay his hands upon in the field—chiefly empty cigar-boxes, all sorts of pasteboard boxes, boxes that had held ammunition for collectors, etc. All had been stored away and was covered with the dust of time. However, I gave the lot a preliminary going over, and Professor Baird promptly assigned to my department—the department of comparative anatomy—an old

lady with a feather duster, requesting me to make known to him anything else I might require. My assistant immediately started in with the duster, and the material was brought to light. A request of mine for an assorted lot of cardboard boxes was favorably considered early in my work; in due course the collection of bird skeletons was *boxed,* the specimens labeled, and the whole made accessible for the use of students.

At this stage of the proceedings a board appointed by the government found me unfitted for promotion (Doctor Coues was also at work in the Smithsonian Institution), and I was ordered to New Orleans. Dr. Lucas succeeded me; and through his splendid energy and genius, the department of comparative anatomy was placed on a sound basis, with a wealth of material of all kinds, elegantly exhibited and cased. Indeed it was, at the close of his régime, the envy and admiration of all the scientific institutions in the world that knew anything about the department. After Dr. Lucas's connection with the National Museum was severed, and I had been, upon second thought of the government, found fitted for promotion and duly ordered *west,* the department of comparative anatomy seemed to slowly dwindle away, finally being split up among the various divisions of the National Museum. Eventually the bird alcoholics and skeletons drifted into Professor Ridgway's division, and, through no fault of his, a long period of *statu quo ante lucasum* set in.

During my seven years' study of crime and human psychology and morphology in New York City I wrote but few papers on the osteology of birds, and these were based principally on material sent me by the Bureau of Science at Manila and the Zoological Society of London. Then, when I returned to Washington to live, my work in vertebrate anatomy was more actively taken up, as I had determined it should be before the sojourn in New York was decided upon. At the end of four or five years or more, when my published memoirs in that field began to run up into the dozens, and the figures illustrating them into many hundreds, I found that I was deeply indebted to the United States National Museum for the loan, at different times, of a great number of bird skeletons used in that particular field of my work. The assistance rendered me by that institution has proved invaluable, and the aid given by Professor Ridgway, and by Dr. Richmond and his assistants, has been and is most thoroughly appreciated.

For a year or more past I have observed, without commenting upon the fact, that there has been a slow but steady improvement upon the former condition of things in the section containing the boxed collection of bird skeletons. Notwithstanding his arduous duties as assistant curator of the division of birds, Dr. Richmond has made a requisition for a series of cases to contain the collection, and these are now in use in a fairly convenient place in the department. A "cleaning up" gradually followed, and a raking together of all the bird skeletons that were in various rooms in the museum. These were placed in trays, to be eventually cleaned and boxed. But what was to be done with them? Professor Ridgway, deep in completing his great work on "The Birds of North and Middle America," could not, even had he wished to do so, think of giving the matter a moment's attention, and Dr. Richmond has as much as he can possibly handle by attending to the affairs of one of the most important departments of the museum—the division of birds, with its enormous collection of bird skins, with its library and correspondence, and with other duties too numerous to mention.

At this juncture, through fortunate circumstances, Mr. Alex. Wetmore, of the Biological Survey, became interested in the matter, and through a mutual cooperation of all concerned, he arranged to put the collection of bird skeletons into the various cases supplied for them, and to settle the material in place as best he could, after his duties at the survey were over for the day. This has been accomplished as far as could be expected under the circumstances, and Mr. Wetmore has emphasized the interest he has taken in the new order of things by publishing a number of

brief though important contributions to bird anatomy.

The interest of the veteran ornithologist, Mr. Oberholser, has also been aroused, and therefore it is likely that additional good results will be forthcoming.

Thus matters seem to stand at the present time, and there is hardly any room for doubt but what an added interest is being taken in this most important branch of biology. If it be genuine and progressive, American science is to be heartily congratulated; should it lead to the appointment of a curator of the department of bird anatomy—of one who understands the *aims* and *needs* of such a department and who has the *energy* to make it in time what it should be, I feel sure that there are congratulations in waiting when such a happy sequel materializes.

Personally, I have always regretted that the division of comparative anatomy of the U. S. National Museum was dissolved, as this was a *prima facie* evidence of a stage of decadence setting in, in a very vital part of the scientific organism. It should be put on foot again in full force, and brought up to the standard where it properly belongs. We are terribly wasteful in such matters; the absence of a division of comparative anatomy in the United States National Museum can only be equaled by the present and corresponding deficiency in the matter of a prosectorial department connected with the National Zoological Park at Washington, where animals frequently die and no attempt is made whatever to examine and report upon their anatomy.

America is coming to the front in many things now besides in what the dollar means, and it should be the aim of science to look well to it that this field is brought properly into line.

R. W. Shufeldt

Washington, D. C.

SCIENTIFIC NOTES AND NEWS

Dr. Percival Lowell and Professor F. Schlesinger have been elected honorary fellows of the Royal Astronomical Society of Canada.

Professor S. W. Williston, of the department of geology and paleontology of the University of Chicago, has been appointed director of the Walker Museum.

Professor J. G. Sanders has resigned as state entomologist of Wisconsin to become economic zoologist of Pennsylvania. His work at Harrisburg begins on September 16, 1916. Dr. S. B. Fracker has been appointed acting state entomologist of Wisconsin by the commissioner of agriculture, and will have charge of the work of the state entomologist's office until a successor to Professor Sanders is appointed.

C. H. Hadley, Jr., of the department of entomology of Cornell University, has been appointed extension entomologist at the Pennsylvania State College.

Dr. Robert Armstrong-Jones has retired from the post of medical superintendent of the London County Lunatic Asylum. A special pension has been awarded to him on the recommendation of the Asylums Committee of the London County Council.

Dr. Linsly R. Williams, deputy commissioner of the New York State department of health, has been appointed by Governor Whitman to conduct an investigation into the proposed building of a garbage disposal plant for New York City on Staten Island.

The Mississippi Valley Conference on tuberculosis will be held at Louisville, Ky., from October 4 to 6, under the presidency of Walter D. Thurber, of Chicago.

Mr. Wellington Jones, of the department of geography, University of Chicago, is traveling in eastern Asia in preparation for the giving of courses in the geography of Asia.

The faculty of medicine of the University of Toronto, which suffered from the enlisting of professors for service in connection with the University Base Hospital, will be strengthened by the return of Dr. John J. MacKenzie, professor of pathology and bacteriology, and Dr. Benjamin P. Watson, professor of obstetrics and gynecology.

During July the botanical laboratory of the Purdue Experiment Station at Lafayette, Ind., had the services of Dr. Frank D. Kern and Professor C. R. Orton, of the Pennsylvania

State College; Dr. F. D. Fromme, of the Virginia Polytechnic Institute, and Mr. C. A. Ludwig, research student of the University of Michigan, all former members of the laboratory staff. They came to assist in the preparation of the remaining parts of the Uredinales for the "North American Flora."

PROFESSOR LAWRENCE MARTIN, of the University of Wisconsin, assisted by Mr. F. T. Thwaites, had a class of 22 men doing field work in geology and geography in the Devil's Lake region (Wis.), during the month of August.

WE learn from the *Journal* of the American Medical Association that the International Health Board has taken up the consideration of the subject of malaria under the phases of geographic distribution and district of infection. Two sets of experiments to test the practicability of malaria control are being carried out; one, the detection of the carriers and freeing them of the parasites, and the other a combination of control measures. The first experiment is being carried out in Bolivar County, Miss., under the administration of the Mississippi Department of Health, with Dr. Walter S. Leathers, University, as administering director and Dr. Charles C. Bass, New Orleans, as scientific director. The field force and microscopists have received their technical training in the laboratory of Tulane University. The second series of experiments is being carried out in Arkansas in cooperation with the United States Public Health Service, under the charge of Surgeon Rudolph H. von Ezdorf.

THE annual New England forestry conference under the auspices of the Society for the Protection of Forests and the New Hampshire State Forestry Commission, was held at the Crawford House, last week. At the formal opening of the conference addresses were made by William L. Hall, chief purchasing agent of the government under the Weeks' Act, and by William P. Wharton, of Groton. At the general sessions Professor Filibert Roth, director of the forest school in the University of Michigan, presented a paper showing how an owner of a wood-lot may estimate the value of his woods. There were addresses by Arthur A. Shurtleff, of Boston; Dr. B. E. Fernow, president of the Society of American Foresters, and dean of the forestry school of the University of Toronto, and by Professor James A. Toumey, director of the Yale Forest School.

OFFICERS of the Society for the Promotion of Engineering Education elected at the annual meeting are: *President,* G. R. Chatburn, University of Nebraska; *First Vice-president,* Hollis Godfrey, Drexel Institute; *Second Vice-president,* W. M. Thornton, University of Virginia; *Secretary,* F. L. Bishop, University of Pittsburgh; *Treasurer,* W. O. Wiley, New York, N. Y.; *Members of the Council to serve for three years,* E. J. McCaustland, University of Missouri; F. G. Higbee, State University of Iowa; R. W. Gay, Mississippi College; T. E. French, the Ohio State University; A. H. Blanchard, Columbia University; A. A. Potter, Kansas State Agricultural College; Wm. H. Browne, Jr., North Carolina College.

DR. CHARLES R. BARDEEN, professor of anatomy and dean of the medical school of the University of Wisconsin, delivered an address on August 31 before the graduate school of medical sciences of the University of Illinois on "Study of the Anatomy of the Heart in the Living by the Use of the Roentgen Ray."

THE United States Civil Service Commission announces an examination for scientific assistant, for men only, on October 4, to fill vacancies in the positions of scientific assistant and field assistant at $900 to $1,400 per annum in the Bureau of Fisheries, Department of Commerce.

THE Wellcome Historical Medical Museum, London, will be closed until September 30, when it will reopen with a loan exhibition illustrating the folk-lore of London, including medical charms, amulets and other objects found to have been used by the superstitious in connection with the cure and prevention of disease.

THROUGH a gift from Sir Charles Parsons the British National Physical Laboratory has

made arrangements, at the request of the Röntgen Society, for the examination of materials employed for the protection of X-ray workers.

WE learn from the *British Medical Journal* that the late Miss Mary Hamilton, of Glasgow, left £165,000 to Scottish institutions, including £30,000 to the Western Infirmary, Glasgow, for a Hamilton ward and £7,500 for ordinary purposes; £10,000 to the Glasgow Royal Infirmary for ordinary purposes; £7,500 each to the Glasgow Hospital for Sick Children and the Edinburgh Royal Infirmary; £7,500 to the Victoria Infirmary, Glasgow; £5,000 to the Royal Edinburgh Hospital for Incurables; and £1,000 each to the Glasgow Ophthalmic Institution, Glasgow Hospital for Diseases of the Ear, Nose and Throat, and the Glasgow Eye Infirmary.

IT is stated in *Nature* that at the meeting of the City of London Court of Common Council, on July 20, it was resolved: (1) That in view of the great advantages which would accrue to British commerce in foreign markets by the use of the decimal system of coinage and weights and measures, in the opinion of this court it is desirable that steps should be taken to ensure its immediate introduction, so that it may be already in operation at the conclusion of the war; (2) that in view of the fact that England and the Allies are entering into arrangements for concerted action with regard to future trade matters, it would be of immense value if one language could be recognized as the commercial language, and taught in all schools, here and abroad. By so doing, English, French, Russian, Esperanto or any other language decided on would form the basis of communication on business matters throughout the world.

AT the fifty-third meeting of the American Chemical Society, to be held in New York City during the last week of September, the division of biological chemistry will hold, on Wednesday morning, September 27, a joint session with the division of physical and inorganic chemistry to discuss theoretical colloid chemistry. On Thursday morning a joint session with the division of industrial chemists and chemical engineers will be held to discuss the practical applications of colloid chemistry. On Friday and Saturday mornings the division of biological chemistry will meet for the presentation and discussion of the papers of its regular program. Papers on colloidal chemistry are as follows:

D. B. Lake, "Irreversible Absorption of Dyes."

A. B. Macallum, "Surface Tension of Protoplasm."

G. H. A. Clowes, "Phase Relations in Biological Systems."

W. D. Bancroft, "Displacement of Equilibrium of Catalytic Agents."

E. F. Farnan, "Stabilization."

E. L. Mack, "Showerproofing."

J. M. Ball, "The Photographic Developer."

Irving Langmuir, "Structure of Liquids with Particular Reference to Surface Tension."

T. R. Briggs, "Electrical Endosmose."

Charles Baskerville, "Refining of Oils."

C. J. Fink, "Relation between Chemical Composition and Electrical Resistance."

T. R. Briggs, "Paints."

L. A. Keane, "Yellow Bricks."

D. Spence, "Vulcanization of Rubber."

A. W. Davison, "Adsorption of Chromium Hide Powder."

A. W. Fisher, "Adsorption of Sulphuric Acid by Hide Powder."

Clifford Richardson, "Asphalt."

L. A. Keane, "Plaster of Paris."

Jerome Alexander, "Selective Adsorption and Differential Diffusion."

H. W. Gillett, "Emulsion and Suspensions with Molten Metals."

C. L. Parsons, "The Purification of Kaolin."

W. D. Bancroft, "Fritting and Fusing."

UNIVERSITY AND EDUCATIONAL NEWS

THE University of Chicago has received a fund to create the Edith Barnard Memorial Fellowship in Chemistry. Miss Barnard, who was instructor in the department of chemistry when she died, had received three degrees in science from the university, that of bachelor of science in 1903, that of master of science in 1905, and that of doctor of philosophy in 1907; and she had been connected with the department for ten years.

Berea College announces a gift of $10,000 from the late James Talcott, of New York City, received shortly before his death. This gift was part of a total pledge for $40,000 for the erection of a girls' dormitory, which will be ready for occupancy on January 1.

The New York School of Dental Hygiene has become allied with the new Columbia University School of Dentistry and the College of Physicians and Surgeons. The school will open on September 27, classes being held in the Vanderbilt Clinic.

Irving H. Blake, A.M. (Brown, '12), instructor in the Oregon Agricultural College, has been appointed instructor in the department of zoology, Syracuse University.

Mr. Charles Colby, recently of the Peabody College for Teachers, Nashville, Tenn., has become instructor in geography at the University of Chicago.

At the University of Chicago, Anton Julius Carlson, of the department of physiology, and Charles Manning Child, of the department of zoology, have been promoted to professorships. Lee Irving Knight, of the department of botany, has been promoted to an assistant professorship. New appointments are: Ernest Watson Burgess, of Ohio State University, to be assistant professor in the department of sociology and anthropology; Professor Jean Piccard, of the University of Lausanne, Switzerland, to be assistant professor in the department of chemistry, and Dr. W. B. Sharpe and William E. Cary, to be instructors in the department of hygiene and bacteriology.

DISCUSSION AND CORRESPONDENCE

PRESIDENT WILSON'S SCIENTIFIC APPOINTMENTS

The two articles in Science of August 25, 1916, on "Scientific Appointments under the Government" and "President Wilson's Scientific Appointments" are interesting and suggestive, but not entirely convincing. They do not fully cover the question; the writers were apparently not familiar with a number of facts which have a very important bearing upon the point at issue. In fairness to all concerned it is necessary to call attention to a few scientific appointments made by the Wilson administration about which the writers failed to enlighten the readers of Science and *The Scientific Monthly*.

In the first place, it has been generally understood (and even claimed by some of the parties interested) that the original administration slate contemplated the appointment of E. Lester Jones to the position of commissioner of fisheries. That this slate was broken is much to the credit of the American Society of Naturalists and the American Society of Zoologists. But what followed? The president immediately appointed Mr. Jones deputy commissioner of fisheries. That position, in many respects, even more important to science than that of the commissionership itself, and which should have been filled only upon the recommendation of the commissioner, was at once filled by the appointment of Mr. Jones. The commissioner of fisheries was not even consulted. He was completely ignored by the president and the secretary of commerce not only in this case but in other important appointments in the bureau of fisheries, a few of which may be mentioned. One of the first was the appointment, without even consulting the commissioner of fisheries, of a young man as private secretary to the commissioner. It would seem that the chief of an important bureau should be permitted to select his own private secretary, the position being so distinctively personal and confidential. The young man appointed was, it is understood, from the home town of John H. Rothermel, at that time a congressman from Pennsylvania and chairman of a committee of the House that had been for some years conducting certain fur-seal hearings. The young man was neither a stenographer nor a typewriter (it was said he was a plumber). It was said at the time (and there is every reason to believe it was true) that he was appointed as a spy to keep Rothermel and Henry W. Elliott informed as to the commissioner's relations to fur-seal matters, in which Rothermel at that time was very active—so active, indeed, that at the next

election, he was unable to explain certain charged irregularities and his constituents declined to return him to congress.

Another flagrant violation of the principles of the civil service and a total disregard of fitness was the appointment of one H. O. Smith, of Palestine, Illinois, as chief Alaska salmon agent. This appointment was made without consulting the commissioner of fisheries or the chief of the Alaska fisheries service, and after the secretary of commerce had assured the commissioner of fisheries that he would promote to the position the assistant Alaska salmon agent, Mr. Ward T. Bower, a thoroughly competent and experienced man. H. O. Smith openly claimed that his appointment was made at the instance of Senator James Hamilton Lewis, of Illinois.

The duties of the Alaska salmon agent, like those of a deputy commissioner of fisheries, are highly technical, and require special knowledge and experience of the fisheries. Neither Mr. Jones nor Mr. Smith possessed even elementary knowledge of fishes or fisheries; it was apparent that neither could tell a salmon from a sucker. Each of them made at least one tour of inspection of the Alaska fisheries, bringing discredit upon the bureau wherever they went, so lacking were they in knowledge or appreciation of the problems of the fisheries. The voluminous and profusely illustrated report by the deputy commissioner will probably never be excelled in the number of inaccuracies, absurd statements, fairy stories and erroneous conclusions it contains.

One other case may be mentioned, one with which the National Academy of Sciences is concerned. In the spring of 1914 the administration decided to send a special commission of zoologists to the seal islands of Alaska. The secretary of commerce, when a member of congress, had voted for a bill which prohibits all commercial killing of fur seals for five years in spite of the fact that every zoologist in America, England, Russia and Japan who had studied our fur-seal herd advised against such a course.

Having taken a position favoring the suspension of commercial killing the secretary might very properly decline to reverse his opinion until he had secured further information. The administration thought this information could be secured by sending a special commission to the islands. To assist in selecting the members of the commission the president asked the National Academy of Sciences, the secretary of the Smithsonian Institution and the secretary of agriculture each to nominate one member of the commission. This was done. The National Academy of Sciences nominated a very able and distinguished zoologist, Dr. George H. Parker, of Harvard University. The commission went to the seal islands in the summer of 1914, made a study of the seal herd and, upon their return to Washington, submitted a very comprehensive report, in which, evidently to the surprise of the secretary of commerce, every important thing for which Clark, Jordan, Evermann, Stejneger, Lucas, Osborn, Townsend, Merriam, Lembkey and others familiar with fur-seal matters had contended, was sustained.

The report contained a number of recommendations, the most important of which was the immediate repeal of the law which prohibits commercial killing of seals, and for which Mr. Redfield had voted and which he had said, as late as October 13, 1913, was "a sound and wise one."

Dr. Parker and his associates submitted their report to the commissioner of fisheries on January 23, 1915, by whom it was promptly transmitted to Secretary Redfield on January 25. Although the report contained recommendations of vital importance to the fur-seal herd, which if acted upon promptly would save hundreds of thousands of dollars to the government as well as save the seal herd from irreparable injury, Mr. Redfield pigeonholed the report for more than three weeks and did not transmit it to congress until February 17, only a few days before congress adjourned. And, very strangely, and to the great disappointment of the commission, Mr. Redfield studiously refrained from calling attention to any of the recommendations of the commission; nor did he make any recommendation himself that congress should take any action

on the recommendations of the commission. In fact, it is understood that it was Mr. Redfield's desire that congress should not take any action. He wholly ignored, and wished congress to ignore, the recommendations of the commission named by the National Academy of Sciences, the secretary of the Smithsonian Institution and the secretary of agriculture. It would be proper for the National Academy of Sciences, the official adviser of the government on scientific matters, to ask the president what action, if any, has been taken on the recommendations of the board which it assisted in naming; and if called upon again for expert advice, the academy would do well to inquire whether any attention would be paid to its advice when given.

The statement in *The Scientific Monthly* article that E. Lester Jones "has proved to be an efficient executive" was probably made without intimate knowledge of the facts. It is well known in the bureau of fisheries that just the reverse was true, as was clearly shown by the very extravagant and unbusiness-like administration of Alaska fishery matters of which Mr. Jones took entire charge. Two or three illustrations may be given. It is understood that the sending of supplies to the seal islands under Mr. Jones's management cost the government several thousand dollars more than it had cost before, and yet the natives suffered severely for want of food.

A certain important scientific investigation of the Alaska salmon, begun in 1910 and which required at least six years to reach conclusive results, was stopped in 1914, thus breaking the continuity of the investigation, with the result that the whole thing must be done over again if the results are to be of any value.

If these illustrations of inefficiency are not enough, inquiry might be made regarding the boat *Roosevelt* purchased by Mr. Jones for the Alaska service.

But if the appointment of a politician to the head of a scientific bureau is justified because the appointee proves to be a good executive, then President McKinley's appointment of Mr. Bowers as Commissioner of Fisheries is fully justified, as Mr. Bowers proved to be an excellent executive, who gave the bureau of fisheries a thoroughly business-like administration, during which more real productive scientific work was done than ever before by the bureau.

BARTON WARREN EVERMANN

FIREFLIES FLASHING IN UNISON

IN SCIENCE of February 4, 1916, page 169, I recorded for the first time an observation made fifty years ago of a large number of fireflies flashing in perfect unison. I have been on the lookout ever since that time for a confirmation of my observations, consulting every book on entomology and watching the fireflies ever since for the recurrence of this phenomenon without success. In *Nature* for December 9, 1915, is recorded a paper by W. G. Blair, Esq., entitled "Luminous Insects" in which reference is made to the remarkable synchronism of the flashes in certain species of European fireflies. A somewhat extended extract is given from Mr. Blair's address. A copy of this paper was sent to my friend Professor E. B. Poulton, of Oxford, and in return he has sent me a proof sheet from a book he is editing entitled "A Naturalist in Borneo" by R. Shelford, who died a few years ago, a former assistant of Professor Poulton. I am taking the liberty of presenting an extract from this advanced page:

> On the opposite bank was a small tree growing close to the water's edge, which was covered with thousands of fire-flies, small beetles of the family Lampyridæ; and I observed that the light emitted by these little creatures pulsated in a regular synchronous rhythm, so that at one moment the tree would be one blaze of light, whilst at another the light would be dim and uncertain. This concerted action of thousands of insects is very remarkable and not easy of explanation. Another instance of it was mentioned by Cox; certain ants that are found very frequently proceeding in columns along the floor of the jungle, when alarmed, knock their heads against the leaves or dead sticks which they happen to be traversing; every member of a community makes the necessary movement at the same time, and as the movements are rapid a distinct loud rattling sound is heard. In this case the action is probably a danger-signal, and we can understand—theoretically at any rate—how it was brought

about. But the value to the species of the rhythmic-light pulsation of the fire-flies is not obvious, and as it is doubtful if the emission of phosphorescent light is under the control of the insect, or is merely a simple automatic process of metabolism, its synchronism is a most puzzling fact.

Dr. Hermon C. Bumpus wrote me that some years ago in riding from Falmouth to Woods Hole his attention was arrested by noticing in a field along the road a large number of fire-flies flashing synchronously.

Edward S. Morse

A FURTHER NOTE ON POLYRADIATE CESTODES

The issue of Science for February 4, 1916, N. S., Vol. 43, No. 1101, page 170, contains a note by Professor Barker referring to my article on "Polyradiate Cestodes" published in the *Journal of Parasitology*, September, 1915, calling attention to the omission of his previously reported cases of triradiate specimens of *Tænia pisiformis* and *T. serialis*, and to my error in considering that the case of triradiate *T. pisiformis* which I reported was the first on record. This is a valid criticism and it is regrettable that Professor Barker's paper should have been overlooked. None of the other criticisms made by Professor Barker, however, seems justifiable.

In the first place, in regard to the specific identification of the parasite, it has been my experience in the course of several years, during which time a large number of specimens of dog tapeworms have been examined, that *Tænia pisiformis* may be readily determined upon the basis of the gravid segments alone.

As to the other criticisms made by Professor Barker, although I attach much less importance to the results of the feeding experiments which I carried out than Professor Barker apparently supposes (for the reason that the results of a single experiment of that kind are of no great value as a rule, except when supplemented by the results of other experiments) it seems proper to discuss briefly certain points in my paper which appear to have been misinterpreted by Professor Barker.

With reference to using, in feeding experiments, material which had been in formalin for a few days, it was noted in my article that the use of such material on several other occasions had always resulted in the infestation of the experiment animals. In fact it has been found by repeated experience by myself and others in this laboratory, that the ova of *T. pisiforis* are extremely resistant to the action of formalin. Rabbits fed segments of *T. pisiformis* which have been kept a few days in a solution of formalin, not infrequently die shortly afterwards and on postmortem examination show a massive invasion of the liver with the early larval stage of the parasite.

It is a well-known fact that in the case of several species of parasites, the ova of which are characterized by a relatively thick egg shell, the eggs are affected but little if at all by formalin solutions. Ascarid eggs for example may be kept alive for months or even years, in formalin. Morris[1] when examining some human feces which contained many eggs of *Ascaris lumbricoides* and which had been preserved in a 2 per cent. solution of formalin for two years, found that some of the eggs contained actively motile embryos. Four months later there was an apparent increase in the number of eggs containing embryos. In my own experience it has been found that a formalin solution is a very satisfactory medium in which to incubate ascarid eggs, as it prevents the growth of molds, bacteria, etc., without interfering with the development of the embryos. Various other substances commonly destructive to protoplasm have been found not to interfere with the development of ascarid eggs. Leuckart[2] notes that the eggs of *Ascaris mystax* may reach complete development in alcohol, chromic acid and turpentine, while Bataillon[3] has had ova of *Ascaris megalocephala* showing living embryos after having been for six months in Flemming's solution. The latter also finds that the embryos in the eggs remain intact and active in 50 per cent. alco-

[1] *Johns Hopkins Hospital Bulletin*, Vol. 22, August, 1911, pp. 299–300.

[2] "Die menschlichen Parasiten," Vol. 2, 1 Lief., 1867, p. 212.

[3] *Arch. Entwickelungsmech.*, Vol. 2, 1901, p. 149.

hol, in a $33\frac{1}{3}$ per cent. solution of acetic acid and in a 20 per cent. sulphuric acid solution.

Concerning Professor Barker's suggestion in regard to the uncertainty as to the previous natural infection of the rabbit used, it should be noted that in the article in the *Journal of Parasitology* I stated that it could not be positively demonstrated that the rabbit was uninfested at the time it was fed. Attention, however, was called to the fact that spontaneous infestation among rabbits from the same source was unknown, and it was considered that this was very strong evidence for assuming that the cysticerci found in the rabbit resulted from the feeding experiment. How strong this presumptive evidence was will be seen from the following:

The records of the Bureau of Animal Industry Experiment station at Bethesda, Md., show that about 5,000 rabbits have been reared and used for laboratory purposes. By inquiry among the members of the bureau laboratories where these rabbits have been used, it was learned that cysticerci have never been observed in any case except as the result of experiments in which tapeworm eggs were fed to the animals. As all these rabbits are reared under practically identical conditions and the greater number of them during and subsequent to the experiments in which they are used, are kept until death under essentially the same conditions as my experiment rabbit, it would seem that the feeding experiment with proglottids of a triradiate *T. pisiformis* was very well safeguarded by checks, and that the results though (as was noted) not conclusive, justified the statements which I made to the effect that the feeding experiment in question tended to show that normal larvæ may result from the eggs of triradiate adults, and on the other hand that it failed to demonstrate the development of abnormal larvæ from polyradiate adults. In other words, recognizing the inadequacy of a single feeding experiment, I did not draw any definite conclusions from the results. I accepted these results merely as indicating certain probabilities and placed them on record so that they would be available for reference to others who might have opportunity to undertake feeding experiments with the eggs of polyradiate cestodes.

Winthrop D. Foster

Zoological Division,
Bureau of Animal Industry,
U. S. Department of Agriculture

QUOTATIONS

SCIENCE AND COMMERCE

In commenting on the report of the National Physical Laboratory for 1915–16, *Nature* recalls the serious anxiety caused to those responsible for the supply of optical munitions by the shortage of suitable glass at the beginning of the war, for the industry of optical glass production had tended more and more to become a German monopoly. With the aid of a grant from the Privy Council Committee for Scientific and Industrial Research, a number of inquiries were instituted. So far the main work has been directed to the production of satisfactory pots, since one of the principal difficulties in the manufacture of optical glass lies in the choice of suitable material for the pots in which it is made. Similar work on heat-resisting materials, and generally on the behavior of the rare earths and other substances at high temperatures, is of great importance in a large number of industrial processes, but for such work a technological laboratory on a large scale is needed, and will, it is hoped, be provided. Other research on chemical and other glasses has been done during the year by the National Laboratory, as well as by other institutions. The work is of the utmost national and scientific importance, and our scientific contemporary expresses the hope that the committee will spare no effort "to ensure that it is actively continued and extended, and that in the future no risk shall be run of this fundamentally important industry passing into foreign hands."

The committee is in a good position to achieve the first object, and the acquisition of scientific knowledge and the perfecting of technical methods will make the attainment of the second possible, but it will not do more; commercial organization is necessary, and also probably state action. As an example of what

happens we may say that we had occasion a short time ago to make some inquiries as to a particular kind of glass, and found that though its formula was due to British research, and though it had been and perhaps is still being made in this country, commercial control was in the hands of foreigners.

The position with regard to the production of fine chemicals and synthetic drugs and the commerce in them is very similar to that in which the authorities of the National Physical Laboratory found the manufacture of optical glass. In commenting, in the *Journal* of August 12, on the resolutions adopted by the Annual Representative Meeting recommending medical practitioners to avoid using drugs made in Germany or Austria if identical substances manufactured by ourselves or by our Allies can be obtained, and instructing the council to bring to the notice of the government the possibility of guaranteeing protection to firms willing to lay down plants to manufacture drugs and chemicals made in Germany before the war, we pointed out that while it was probably the opinion of the majority of chemical manufacturers that some form of government assistance by tariff or otherwise was necessary, yet a considerable degree of cooperation among manufacturers is a more fundamental requisite for the establishment of the manufacture of synthetic drugs on a sound commercial basis.

It is probably owing to the resolutions of the Annual Representative Meeting and this comment on them that Dr. Sidney Barwise, medical officer for Derbyshire, has sent us a copy of a pamphlet on economics and the war which he published last May. Dr. Barwise refers to the resolution adopted by the Chambers of Commerce of the United Kingdom "that the strength and the safety of the empire lie in ability to produce what it requires from its own soil and factories," and compares it with a famous pronouncement of Alexander Hamilton during the American War of Independence: "Every nation . . . ought to endeavor to possess within itself all the essentials of national supply. These comprise the means of subsistence, habitation, clothing and defence. . . . The possession of these is necessary to the progress of the body politic; to the safety as well as to the welfare of the society. . . . To effect this change, as fast as shall be prudent, merits all the attention and the zeal of our public councils; it is the next great work to be accomplished."

Far be it from us to enter upon the thorny controversy as to free trade and tariff reform, which excites a degree of bitterness in the extreme champions on either side difficult for persons of scientific training to understand, but we are entitled to call attention to the effect on the nation's health and virility of the exodus from country to town, due in part at least to the depression of agriculture and the fact that peasant proprietors in Great Britain are so few as to be negligible in any general view. One result of the fiscal policy of Germany has been to keep the people on the land and to encourage small freeholders; in thirteen years one and a half million acres were thrown into small holdings. A similar fiscal policy in France has had a similar result. Before the passing of the Méline tariff law of 1892 France imported 441 million francs' worth of agricultural produce; ten years later she was exporting an excess of 152 million francs' worth, peasant proprietors had increased and the tide of population was set back from the town to the land. In thirty years the import of cereals into Great Britain more than doubled, while the population increased by less than a third. In the same issue of *Nature* as that from which we have already quoted there is a note on a recent report by Mr. T. H. Middleton, assistant secretary of the Board of Agriculture. He shows that it is not an empty boast to say that on each hundred acres of cultivated land Germany feeds seventy people, while Britain can only feed forty-five. According to this report, the two chief factors in the recent remarkable development of German agriculture are a settled economic policy and a well-thought-out system of agricultural education; coupled with these is the belief of the German farmer that he was essential to the community and that his land should not be allowed to go

out of cultivation. Mr. Middleton states that the chief immediate cause of the increased productivity of German soil is the increase in use of artificial manures; twice as much nitrogen, one third more phosphate, and five times as much potash are used in Germany as on an equal area of our cultivated land. The reason Mr. Middleton gives for this failure of the British farmer is want of education, but he thinks that this defect in our educational system is being remedied. There are, however, undoubtedly other causes, which might more quickly be removed, for the depression which has affected British agriculture during the last seventy and especially the last thirty or forty years.—*British Medical Journal.*

SCIENTIFIC BOOKS

An Introduction to the Study of Color Vision. By J. HERBERT PARSONS, D.Sc., F.R.C.S., Ophthalmic Surgeon, University College Hospital; Surgeon, Royal London Ophthalmic Hospital. Cambridge, University Press. 1915. 308 pp.

Dr. Parsons has undertaken to present the facts and the theories of color vision in such form as shall be intelligible to the general reader. He states in his preface:

> The vast literature on color vision consists almost entirely of papers written in support of some particular theory. It is peculiarly difficult to obtain a general and unbiased view of the subject. I have here endeavored to separate the best established facts of color vision from the theories, and have then discussed the chief theories in the light of these facts.

Accordingly he has divided his book into three parts. The first part (pp. 1–157) is devoted to a statement of the facts of normal color vision; the second part (pp. 158–192) deals with the facts of color-blindness; and the remaining portion (pp. 193–299) discusses theories of color vision.

The author's statement of the facts of normal color vision is prefaced by a brief summary of such phenomena of physical optics and such a description of the structure and function of the visual organ as shall serve as a basis for his subsequent discussion. This is followed by a description of the color vision of the light-adapted eye and of the dark-adapted eye, together with a summary of the temporal and spatial effects of retinal stimulation (after-images, contrast, color-zones and the like). His chapter on the evolution of the color-sense presents evidence derived from the color vision of the lower animals, from the color vision of primitive peoples, and from the color vision of infants. The description of color-blindness summarizes the findings obtained in various investigations of certain typical deviations from normal color vision. The chapters on theories of color vision are prefaced by an historical sketch of the development of color theories, and this is followed by a summary statement of the most widely accepted theories.

Dr. Parsons has attempted a difficult task in his endeavor to present a readable summary of the exceedingly voluminous and exceedingly controversial literature of color vision; and his book bears evidence of painstaking effort and keen insight. The author has exercised sound judgment in selecting and presenting his material; and for the most part he has maintained an admirably non-partisan attitude throughout—except, perhaps, in dealing with the duplicity theory where his approval is more complete than the facts seem to the reviewer to warrant. The features in Dr. Parsons's book which are most likely to excite criticism are the author's tendency toward an uncritical statement of the findings of the various investigators, and his failure to recapitulate his mass of summaries and to give the reader a brief statement of the present status of the various problems. There is perhaps no field of investigation in which the refinement of apparatus and of technique has made greater progress within the past decade or two than in the field of color vision; it follows, therefore, that many of the earlier investigations now possess no more than historical value. It seems to the reviewer to be doubtful wisdom to lump together the findings of good, bad and indifferent investigations, and to present them to the reader without any attempt at critical evaluation. In several instances the

author has employed a loose form of statement—for instance, he speaks of "physiological sensations" (p. 162), and he employs the term color throughout in an equivocal and confusing fashion, sometimes referring to color-stimulus and sometimes to color-sensation; a few inaccuracies of statement are also to be found, of which perhaps the most serious is the assertion that the extreme peripheral region of the retina is totally color-blind (p. 71; p. 258). Although the book will be of doubtful service to elementary students, it may safely be recommended to more advanced workers as a supplement to the earlier and more critical summaries by Mrs. Ladd-Franklin and others in Baldwin's "Dictionary," and by Rivers in Schäfer's "Text-Book of Physiology."

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SPECIAL ARTICLES

THE MAMMALIAN ERYTHROCYTE—A BICONCAVE DISC[1]

The existence of "bell"- or "cup"-shaped red corpuscles in mammalian blood has been recorded frequently since the early observations of Leeuwenhoek (1719).[2] The serious proposal that the cup, and not the classic biconcave disc, is to be considered normal is, however, a comparatively recent teaching which has been received with considerable skepticism. Since these concavo-convex corpuscles may be found in drawn blood, in fixed tissues, and even in circulating blood, the issue obviously hinges on the determination of which is the normal and which the derived form—one or the other representing a modification.

1. *Examination of Drawn Blood.*—It has been claimed (Weidenreich, '02,[3] et seq.; Lewis '04)[4] that drawn blood examined immediately on a warm slide is favorable for the demonstration of cups. According to this view, the assumption of the familiar disc-shape depends on an almost instantaneous change due to the evaporation and concentration of plasma before the preparation can be made and examined.

That the disc-form is normal has been asserted by Jordan ('15)[5] working with blood, diluted with physiological solutions, in culture slides, and by Löhner ('10)[6] who employed a cabinet of sufficient size to contain a microscope and to permit the free use of his hands, introduced through appropriate openings. Within this apparatus, heated to 38° C. and saturated with moisture, blood was drawn from the finger and examined. Löhner reports that the blood corpuscles were "stets und ausschliesslich" biconcave discs.

In ordinary warm slide- and cover-preparations, made as quickly as possible, I have observed a few cups only, but have never followed the transformation of these into discs as the newer hypothesis suggests. The momentary exposure to air necessitated in making ordinary preparations may be practically eliminated by utilizing the following method. Superimposed cover glasses, separated by a hair, are fused at one point by heat; if an edge be now applied to a needle prick in the finger, and the finger squeezed, the issuing blood is drawn in by capillarity. Such preparations, examined quickly, have never yielded evidence for the general existence of the cup-shape. A few cups may usually be found, whereas scores of indubitable discs appear.

Since the experiments of Ranvier, in 1875,[7] it has been known that graded temperatures can alter disc-shaped corpuscles to shallow cups, thick-walled cups or even to spheres—*e. g.*, typical cups are found exclusively when blood is warmed to 55° C. (Zoth).[8] Is it possible that some investigators, who advocate the

1 From the Anatomical Laboratory of the Northwestern University Medical School, Contribution No. 43, July 2, 1916.

2 Leeuwenhoek, A., "Epistolæ physiologicæ," epistola 44, 1719.

3 Weidenreich, F., *Arch. f. mik. Anat.*, Bd. 61, pp. 459–507, 1902.

4 Lewis, F. T., *Jour. Med. Research*, Vol. 10 (N. S., 5), pp. 513–517, 1904.

5 Jordan, H. E., *Proc. Soc. Exp. Biol. and Med.*, Vol. 12, No. 7, pp. 167–169, 1915.

6 Löhner, L., *Arch. f. gesam. Physiol.*, Bd. 131, pp. 408–424, 1910.

7 Ranvier, L., "Traité technique d'Histologie," 1st ed., Paris, 1875.

8 Zoth. Vide Löhner, *op. cit.*

cup shape, have heated unduly their slides and covers in overzealous attempts to maintain normal(!) conditions?

Experimentation in which various "physiological solutions" are used for the dilution of blood may ever, though perhaps unjustly, be subjected to criticism. At best these are artificial media, the tonicity and colloidal constitution of which may or may not simulate blood plasma.

To preclude such criticism natural serum must be used. Accordingly, I had 20 c.c. of blood drawn from my basilic vein. This was defibrinated by whipping and centrifuged quickly; thus an examining medium was obtained, identical with blood plasma except for the loss of one of its minor protein constituents —fibrin.

By utilizing an electrically heated warm-stage, hollow-centered life slides, cover glasses, as well as the air of the cell itself, may be maintained constantly at body temperature. A drop of serum was placed on a finger, previously cleaned with alcohol, and the finger pricked through the drop. The droplet of blood, thus diluted, was touched to a cover and suspended, as a hanging drop in the life cell. Vaseline served to seal the cell, the air in which could be kept saturated with moisture by introducing previously a drop of water and sealing. A few seconds only are required to make such preparations; if a large drop of serum be used the loss by evaporation prior to sealing is inconsiderable, whereas further evaporation in the cell can not occur.

A microscopic examination of blood prepared according to this technique reveals numerous isolated corpuscles. A favorable place for scrutiny is near the center of the drop. Here sinking corpuscles revolve slowly, showing alternately their concave faces. *Usually a few cups can be found, whereas quantities of discs are seen in every field.* This experiment may be varied by filling shallow concave slides with serum into which the drop of diluted blood is introduced. Evaporation is prevented by sealing with a cover and vaseline.

Human sera, kindly furnished by three of my colleagues, gave results identical with those already described, both when corpuscles were examined in their own serum and in each of the other sera. Similar tests have also been made with .85 per cent. and .9 per cent. saline, and with Tyrode's solution. More cogent proof concerning the primary shape of the mammalian erythrocyte, to be derived from the study of drawn blood, I can not imagine.

Various dilutions of human serum with distilled water were next prepared. When a droplet of blood is mixed with a drop of diluted serum containing ca. 40 per cent. water and examined as before, typical cups are found almost exclusively; in dilutions containing ca. 65 per cent. water deeply dimpled spheroids appear; perfect spheres result when the water content is ca. 70 per cent. In concentrated serum erythrocytes crenate. It is evident, therefore, that the shape of a corpuscle is, at least in part, a function of the concentration, *i. e.,* the osmotic pressure, of its medium. In progressively hypotonic solutions corpuscles imbibe increasing amounts of water, ultimately becoming spheres and laking. In hypertonic media, water is given up and crenation results. It is interesting to note that between wide limits these form changes are repeatedly reversible—for example, crenated corpuscles may be restored to the disc- or cup-shape and then recrenated.

The importance of these dilution phenomena on the question of the normal shape of erythrocytes seems to me paramount. *Since the form of a corpuscle depends on the concentration of its medium, how can the cup-shape be normal when human serum must be diluted one third to produce this type?*

Experimentation with the serum of cats and dogs has given comparable results, both with their own and with human corpuscles. The rat, guinea-pig and rabbit have afforded variable pictures, which I believe indicate that the rodent's blood plasma may possess individual variability in its tonicity, thereby rendering this group of animals unfitted for experimentation of this kind.[9]

[9] Details will be given in a later contribution of which present paper constitutes a preliminary note.

2. *Observations on Circulating Blood.*—Weidenreich reported having observed cup-shaped corpuscles in the mesentery of the rabbit ('02) and in the wing of the dormant bat ('03).[10] Lewis ('04) drew similar conclusions from a study of the guinea-pig's omentum, whereas Triolo ('05)[11] recorded finding complete spheres in this animal. Jolly ('05 et seq.),[12] working on the wing of bats restored from hibernation, and Schäfer ('12)[13] on certain mammals (sp. ?) maintain that discs occur. Jordan ('09)[14] found both types, in approximately equal numbers, in the cat.

To avoid the pressure on the vessels caused by the ordinary use of a cover glass and an oil immersion objective, I employed Tyrode's solution (without a cover glass) as in the water-immersion objective of former days. A Leitz no. 4 dry objective and a no. 12 compensating ocular, with the draw tube set at 190 mm. also gave satisfactory magnification.

The omenta of 8 cats and 2 dogs were studied for periods of from 1 to 4 hours. The animals used were in a state of deep surgical shock, the anesthetic having been stopped 2 to 4 hours previously. Regions of the omentum where temporary stasis has caused corpuscles to adhere in clumps or agglutinated masses I do not consider favorable. Ordinary circulation is much too rapid to enable one to make accurate observations. It is sometimes possible, however, to find a bifurcation of medium sized vessels in which the rapid flow selects one limb almost exclusively, separate corpuscles, nevertheless, being intermittently "kicked off" into the slowly moving plasma of the other limb. Such a situation, where the flow is rapid and normal (to find which has sometimes necessitated an hour or more of diligent search) I regard as most favorable for study.[15] Criticisms of pressure from the microscope and of observing capillaries so small that the corpuscles must adjust themselves to their exiguous confines are obviated.

Erythrocytes emerging from the main stream in the way indicated were found to be almost exclusively discs; most of these corpuscles are revolving when first seen and it is easy to be certain of their biconcavity. In such situations I have observed, and have shown to my colleagues, hundreds of discs with only an occasional cup- or saucer-form.

In *anesthetized* guinea-pigs and rabbits cups were very common, and in a dog, under ether anesthesia, a great preponderance of cup-shapes were observed. Is the anesthetic responsible for the cup-shape? The following experiment is highly suggestive. A hanging drop preparation of human blood, or of the blood of a cat or dog, diluted with serum is made. If a drop of ether or chloroform be introduced into the bottom of the cell, the drop takes on the vapor and the discs are seen to change rapidly first to shallow cups, then to deep cups and spheres.

I believe that my observations indicate that the erythrocytes of normal circulating mammalian blood are biconcave discs, the burden of proof resting on those who have used anesthetized animals to show that the anesthetic held in the blood is not responsible for the preponderance of cups observed.

3. *Action of Fixitives.*—Many workers have recorded that mammalian tissues, preserved in various standard fixatives, contain cup-shaped erythrocytes. Should great weight, however, be given evidence of this sort? These corpuscles are plastic structures of extreme delicacy, mere contact with adjacent corpuscles or with obstacles sufficing, when gentle streaming is induced, to cause excessive and varied temporary distortions. Fixation is essentially a coagulation process and it has been shown that the so-called best fixatives actually diminish the diameter of the corpuscle. If, therefore, the reagent does not act on all sides of an erythrocyte simultaneously is not a buckling of the side first fixed to be expected? Indeed

10 Weidenreich, F., *Ergeb. d. Anat. u. Entwickl.*, Bd. 13, pp. 1–94, 1910.

11 Triolo, *Gazz. d. ospitali, Milano*, Vol. 26, p. 393, 1905.

12 Jolly, J., *Comp. rend. soc. biol.*, T. 58, pp. pp. 481–483, 1905.

13 Schäfer, E. A., "Quain's Anatomy," Vol. 2, Pt. 1; 11th ed., Longmans, Green & Co., London, 8vo, 11 and 739 pp., 1912.

14 Jordan, H. E., *Anat. Anz.*, Bd. 34, No. 16 u. 17, pp. 406–412, 1909.

15 For making these observations I can particularly recommend the dog's omentum.

a biconcave shape would invite this alteration. It seems plausible that the delicately constructed and highly flexible erythrocyte is more easily subject to distortion, through the action of reagents, than are ordinary tissues for it is not supported by contiguous cells or by intercellular cement.

The following experiment of Löhner ('11),[16] which I have corroborated, is interesting from this viewpoint. If a droplet of blood be drawn by capillarity between cover slips,[17] fused at one point, discs are observed. If now 1 per cent. osmic acid be drawn in cautiously from one side only, many cups, some wedge-shaped discs, discs, and distorted forms are seen.

A limited number of cup-shaped erythrocytes undoubtedly exist in normal blood. Possibly they represent corpuscles, whose structure is such that unequal tensions with respect to the osmotic balance exist; perhaps they are old (or young?) corpuscles. In anemias the presence of many cups have been reported, and in fevers it is said crenation may occur. May it not be that the blood of certain individuals contains "normally" excessive numbers of cup-shaped corpuscles? Is it possible that this explains why some of our most careful workers have been led to describe this form as normal?

The evidence gained from the examination of drawn blood, diluted in human serum, and from the study of circulating blood in non-anesthetized living mammals justifies, I believe, the conclusion that the biconcave disc represents the normal shape of the mammalian erythrocyte—the concavo-convex cup being merely an occasional modification.

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THE PENETRATION OF BALANCED SOLUTIONS AND THE THEORY OF ANTAGONISM

Antagonism has been explained by Loeb and by the writer on the ground that antagonistic substances prevent each other from entering the cell. As the writer has repeatedly pointed out,[1] this explanation encounters a difficulty in the fact that antagonistic substances penetrate the cell in a balanced solution (although the penetration is much slower than in unbalanced solutions). The proof of this has been obtained by the writer by means of the method of plasmolysis[2] as well as by determining electrical resistances[3] and it has recently been confirmed by Brooks[4] by means of the method of tissue tension as well as of diffusion through a disk of living tissue.

It is obvious that antagonistic substances must penetrate in a balanced solution since otherwise the cell could not obtain the salts necessary to its existence.

As a way out of this difficulty the writer has suggested[5] that the slow penetration of salts may produce effects quite different from those produced by rapid penetration, just as the precipitation of colloids may be brought about by the rapid addition of salts while it does not take place when they are added slowly.

This difficulty completely disappears if we adopt the standpoint recently advocated by the writer in developing a dynamical theory of antagonism.[6] From this point of view we regard the slow penetration of salts in balanced solutions not as the cause but as the result of antagonism, or rather we may regard both the slow penetration and the increased length of life (or growth, etc.), by which we measure antagonism, as the results of certain life processes which are directly acted on by the antagonistic substances.

The essential feature of the explanation lies in the behavior of these life processes rather than in the manner or rate of penetration.

It is assumed that these life processes consist of consecutive reactions of the type

$$A \rightarrow M \rightarrow B$$

[16] Löhner, L., *Arch. f. gesam. Physiol.*, Bd. 140, pp. 92–108, 1911.

[17] Blood should occupy part of the capillary space only.

[1] Science, N. S., 34, 189, 1911; 35, 115, 1912; 36, 576, 1912. *Plant World*, 16, 135, 1913.

[2] Science, N. S., 34, 189, 1911.

[3] Science, 35, 115, 1912; 36, 576, 1912. *Am. Jour. of Botany*, 2, 93, 1915.

[4] Unpublished results.

[5] Science, N. S., 34, 189, 1911; 35, 115, 1912; 36, 576, 1912. *Plant World*, 16, 135, 1913.

[6] *Proc. Am. Phil. Soc.*, 55, 1916.

in which M is a substance which determines the rate of penetration of salts and the electrical resistance of the protoplasm.

If the antagonistic substances are NaCl and $CaCl_2$ it appears that $CaCl_2$ accelerates the reaction $A \rightarrow M$ while both $A \rightarrow M$ and $M \rightarrow B$ are inhibited by a salt compound formed by the union of NaCl and $CaCl_2$ with a constituent of the protoplasm.

From this standpoint the slow penetration of antagonistic substances should not have unfavorable results provided these substances are properly balanced at the start and remain so (*i. e.*, if their relative proportions are not too much changed by unequal speed of diffusion, precipitation, chemical union, etc.) after they enter the cell. For they must affect the life processes mentioned above in quite the same way in the interior of the cell as at the surface[7] and these life processes will go on in the normal way so long as the antagonistic substances within the cell remain properly balanced.

The result will be the preservation of normal permeability as well as of all other properties essential to life.

It has been shown by the writer[8] that the normal permeability may be regarded as a sensitive and accurate indicator of health and vitality. All factors which disturb it bring about temporary or permanent injury and eventually produce death if the action be sufficiently prolonged. It is therefore evident that the life processes which preserve normal permeability are of peculiar importance and that the manner in which they are influenced by antagonistic substances is of especial interest. Methods are being developed for the study of these questions and it appears probable that a considerable amount of information can be obtained in regard to the nature of these processes.

Summary.—Antagonism has been explained by assuming that antagonistic substances prevent each other from entering the cell. A difficulty is found in the fact that they slowly penetrate the cell even in a properly balanced solution. This difficulty disappears if we suppose that the antagonistic substances affect certain life processes which control permeability. So long as they are present in the right proportions their effect on these processes is favorable and their penetration into the cell can do no harm.

The preservation of normal permeability may therefore be regarded as the result rather than as the cause of antagonism.

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[7] Whatever effects are found at the outer surface of the cell are doubtless to be found also at many of the internal surfaces such as the surfaces of vacuoles, plastids, microsomes, etc.

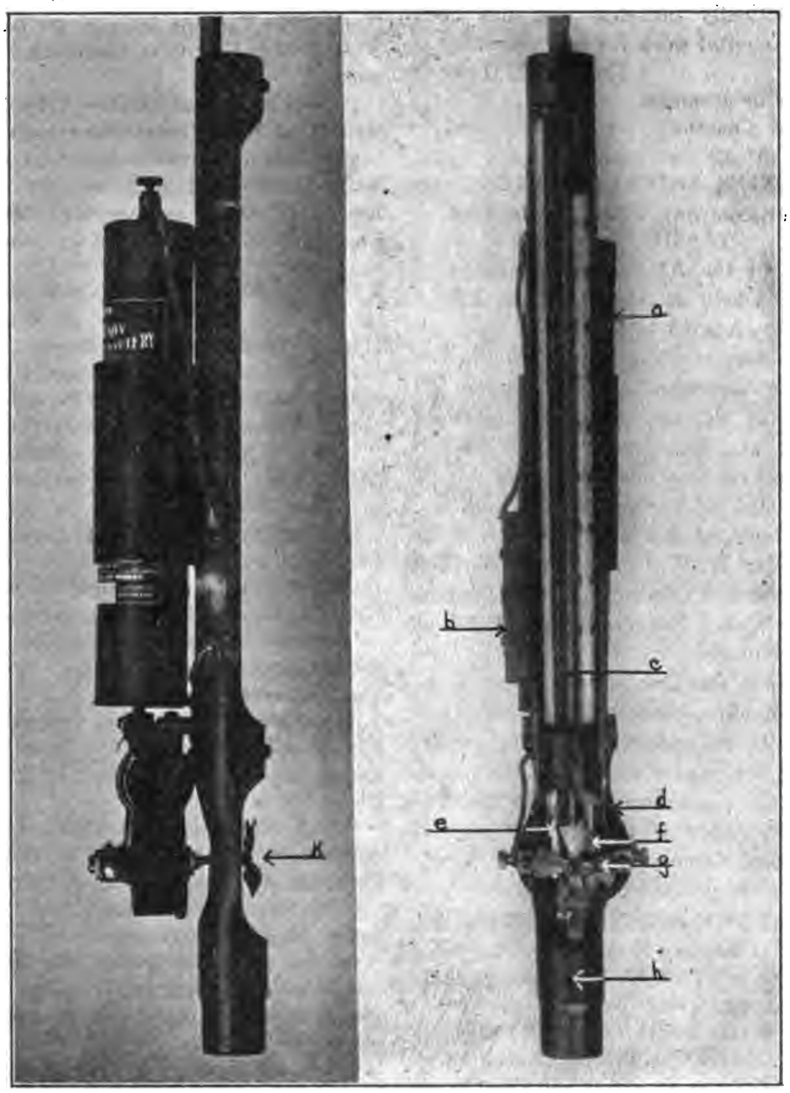
[8] *Plant World*, 16, 143, 1913. SCIENCE, N. S., 40, 488, 1914.

THE DETERMINATION OF RELATIVE HUMIDITY

IN the present stage of knowledge of what constitutes healthful and comfortable air for the average healthy person, the question of the value and significance of the determination of relative humidity is still decidedly debatable. It will, therefore, be necessary to continue such determinations in connection with other types of ventilation tests, in order to assign to relative humidity its proper value as a factor in the problem of conditioning air for health and comfort. There is at least one standard procedure for this determination—the use of the sling psychrometer. This instrument is supposed to give reliable results if used in accordance with the government directions. One need not spend the fancy price for the instrument de luxe. Two thermometers, firmly lashed together in such a way that the bulb of one projects beyond that of the other gives perfect satisfaction. The lower bulb is moistened in the usual way and the pair is swung by a strong cord.

This method has obvious limitations. It can not be used under many circumstances where the determination of relative humidity is desired, *e. g.*, in crowded places, between skin and clothing, etc. It is ofttimes inconvenient and dangerous to use, *e. g.*, in conspicuous places such as churches and libraries, and in cramped quarters such as the berths of

sleeping cars. Outside the realm of hygiene, it is often unsuitable, for example for determining relative humidity among the stems and leaves of seedling plants.



a. Dry cell. *b.* Key. *c.* Tube leading to water reservoir. *d.* Motor. *e.* Dry-bulb thermometer. *f.* Wet-bulb thermometer. *g.* Fan. *h.* Water reservoir. *k.* Direction of air current.

To obviate these difficulties, there have been put upon the market within the last two or three years mechanisms in which not only is the ventilation of the wet bulb accomplished by the obvious and simple method of using a motor-driven fan, but also a graphic record of the readings is kept.

If a continuous record is not desired, it is obvious that the fan ventilation of the thermometer bulbs presents no mechanical difficulties and offers some advantages over the sling method.

In August, 1913,[1] I described such a device in which the fan was moved by clock-work. This I used with satisfaction for a year, but replaced it (see figs.) by an apparatus in which the fan was driven by a toy motor. The latter is practically noiseless and has been used in experimental work for two years.

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SOCIETIES AND ACADEMIES

THE ASTRONOMICAL SOCIETY OF THE PACIFIC

A MEETING of the Astronomical Society of the Pacific was held at San Diego on Thursday and Friday, August 10 and 11, in conjunction with the first meeting of the Pacific Division of the American Association for the Advancement of Science. In the absence of the president and vice-presidents of the society, the meeting was opened by Dr. R. G. Aitken, chairman of the program committee. Dr. W. S. Adams, of the Mount Wilson Solar Observatory; Dr. W. W. Campbell, of the Lick Observatory, and Professor Charles Burckhalter, of the Cabot Observatory, presided at the three sessions held.

The papers at the first session related entirely to the nebulæ, those at the second session principally to spectrographic investigations. All of the papers were fully discussed. Abstracts of the papers are given in the August–October number of the Publications of the Astronomical Society of the Pacific, hence only the titles are printed here.

"Spectrographic Observations of Relative Motions within the Planetary Nebulæ." (Illustrated with stereopticon.) By W. W. Campbell and J. H. Moore, Lick Observatory.

"The Rotation and Radial Velocity of the Spiral Nebula, N. G. C. 4594." (Illustrated with stereopticon.) By Francis G. Pease, Mount Wilson Solar Observatory.

"Forms of Planetary Nebulæ." (Illustrated with stereopticon.) By H. D. Curtis, Lick Observatory.

"Color-photographs of Nebulæ." (Illustrated with stereopticon.) "A Simple Method for Determining the Color of a Star," by Frederick H. Seares, Mount Wilson Solar Observatory.

"Spectrographic Observations of Nebulæ and Star Clusters," by V. M. Slipher, Lowell Observatory.

"On the Motion of Nebulous Filaments in N. G. C. 6992; Variable Stars in the Lagoon Nebula, N. G. C. 6523," by C. O. Lampland, Lowell Observatory.

"Notes on Stellar Clusters," by Harlow Shapley, Mount Wilson Solar Observatory.

"A Relation between the Convergence Wavelengths in Spectral Series and the Radii of their Respective Atoms as Computed from Einstein's Photo-electric Equation and by other Methods," by Fernando Sanford, Stanford University.

"Recent Stellar Spectroscopic Results." (Illustrated with stereopticon.) By Walter S. Adams, Mount Wilson Solar Observatory.

"The Measurement of Close Pairs of Solar Lines," by Charles E. St. John and L. W. Ware, Mount Wilson Solar Observatory.

"The Suggested Mutual Influence of Fraunhofer Lines," by Charles E. St. John, Mount Wilson Solar Observatory.

"Observations with High Dispersion of the Line 6708 in Laboratory and Sun-spot Spectra." (Illustrated with stereopticon.) By Arthur S. King, Mount Wilson Solar Observatory.

"Recent Observations of the Diurnal Change of Refraction at Lick Observatory," by R. H. Tucker, Lick Observatory.

"Preliminary Note on the Determination of the Longitude of the Students' Observatory by Wireless Signals from Arlington," by R. T. Crawford, University of California.

"John Winthrop (1714–1779), America's First Astronomer, and the Science of His Period," by Frederick E. Brasch, Stanford University.

"The Chabot Observatory," by Charles Burckhalter, Chabot Observatory.

"Notes on Certain Double Star Orbits." (Illustrated with stereopticon.) "Note on Barnard's Proper Motion Star," by R. G. Aitken, Lick Observatory.

"Note on Aethra," by Dinsmore Alter, University of California.

"Comet *b* 1916 (Wolf)." (Illustrated with stereopticon.) By R. T. Crawford and Dinsmore Alter, University of California.

"A Luminous Object Seen on May 4, 1916," by C. D. Perrine, Argentine National Observatory.

"A Luminous Object Suspected to be a Comet," by A. Estelle Glancy, Argentine National Observatory.

[1] *Amer. Jour. of Pub. Health*, III., 8, August, 1913.

SCIENCE

FRIDAY, SEPTEMBER 22, 1916

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

NEW ARCHEOLOGICAL LIGHTS ON THE ORIGINS OF CIVILIZATION IN EUROPE[1]

Et quasi cursores vitaï lampada tradunt

WHEN I was asked on behalf of the council of the British Association to occupy the responsible post of president at the meeting in this great city—the third that has taken place here—I was certainly taken by surprise; the more so as my own subject of research seemed somewhat removed from what may be described as the central interests of your body. The turn of archeology, however, I was told, had come round again on the rota of the sciences represented; nor could I be indifferent to the fact that the last presidential address on this theme had been delivered by my father at the Toronto meeting of 1897.

Still, it was not till after considerable hesitation that I accepted the honor. Engaged as I have been through a series of years in the work of excavation in Crete—a work which involved not only the quarrying but the building up of wholly new materials and has entailed the endeavor to classify the successive phases of a long, continuous story—absorbed and fascinated by my own investigation—I am oppressed with the consciousness of having been less able to keep pace with the progress of fellow explorers in other departments or to do sufficient justice to their results. I will not dwell, indeed, on those disabilities that result to myself from present calls and the grave preoccupations of the hour, that to a greater or less extent must affect us all.

[1] Address of the president of the British Association for the Advancement of Science, Newcastle-on-Tyne, 1916.

But archeology—the research of ancient civilizations—when the very foundations of our own are threatened by the new barbarism! The investigation of the ruins of the past—at the time when hell seems to have been let loose to strew our continent with havoc beyond the dreams of Attila! "The science of the spade"—at a moment when that science confronts us at every hour with another and a sterner significance! The very suggestion of such a subject of discourse might seem replete with cruel irony.

And yet, especially as regards the prehistoric side of archeology, something may be said for a theme which, in the midst of Armageddon, draws our minds from present anxieties to that still, passionless domain of the past which lies behind the limits even of historic controversies. The science of antiquity as there seen in its purest form depends, indeed, on evidence and rests on principles indistinguishable from those of the sister science of geology. Its methods are stratigraphic. As in that case the successive deposits and the characteristic contents—often of the most fragmentary kind—enable the geologist to reconstruct the fauna and flora, the climate and physical conditions, of the past ages of the world, and to follow out their gradual transitions or dislocations, so it is with the archeologist in dealing with unwritten history.

In recent years—not to speak of the revelations of late Quaternary culture on which I shall presently have occasion to dwell—in Egypt, in Babylonia, in ancient Persia, in the central Asian deserts, or, coming nearer home, in the Ægean lands, the patient exploration of early sites, in many cases of huge stratified mounds, the unearthing of buried buildings, the opening of tombs, and the research of minor relics, has reconstituted the successive stages of whole fabrics of former civilization, the very existence of which was formerly unsuspected. Even in later periods, archeology, as a dispassionate witness, has been continually checking, supplementing and illustrating written history. It has called back to our upper air, as with a magician's wand, shapes and conditions that seemed to have been irrevocably lost in the night of time.

Thus evoked, moreover, the past is often seen to hold a mirror to the future—correcting wrong impressions—the result of some temporary revolution in the whirligig of time—by the more permanent standard of abiding conditions, and affording in the solid evidence of past well-being the "substance of things hoped for." Nowhere, indeed, has this been more in evidence than in that vexed region between the Danube and the Adriatic, to-day the home of the Serbian race, to the antiquarian exploration of which many of the earlier years of my own life were devoted.

What visions, indeed, do those investigations not recall! Imperial cities, once the seats of wide administration and of prolific mints, sunk to neglected villages, vestiges of great engineering works, bridges, aqueducts, or here a main line of ancient highway hardly traceable even as a track across the wilderness! Or, again, the signs of medieval revival above the Roman ruins—remains of once populous mining centers scattered along the lone hillside, the shells of stately churches with the effigies, bullet-starred now, of royal founders, once champions of Christendom against the Paynim—nay, the actual relics of great rulers, lawgivers, national heroes, still secreted in half-ruined monastic retreats!

Sunt lacrimæ rerum et mentem mortalia tangunt:

Even the archeologist incurs more human debts, and the evocation of the past carries with it living responsibilities!

It will be found, moreover, that such investigations have at times a very practical bearing on future developments. In connection with the traces of Roman occupation I have recently, indeed, had occasion to point out[2] that the section of the great Roman road that connected the valleys of the Po and Save across the lowest pass of the Julians, and formed part of the main avenue of communication between the western and the eastern provinces of the empire, has only to be restored in railway shape to link together a system of not less value to ourselves and our Allies. For we should thus secure, via the Simplon and northern Italy, a new and shorter overland route to the east, in friendly occupation throughout, which is to-day diverted by unnatural conditions past Vienna and Budapest. At a time when Europe is parcelled out by less cosmopolitan interests the evidence of antiquity here restores the true geographical perspective.

Whole provinces of ancient history would lie beyond our ken—often through the mere loss of the works of classical authors—were it not for the results of archeological research. At other times again it has redressed the balance where certain aspects of the ancient world have been brought into unequal prominence, it may be, by mere accidents of literary style. Even if we take the Greek world, generally so rich in its literary sources, how comparatively little should we know of its brilliant civilization as illustrated by the great civic foundations of Magna Graecia and Sicily if we had to depend on its written sources alone. But the noble monuments of those regions, the results of excavation, the magnificent coinage—a sum of evidence illustrative in turn of public and private life, of art and religion, of politics and of economic conditions—have gone far to supply the lacuna.

Look, too, at the history of the Roman Empire—how defective and misleading in many departments are the literary records! It has been by methodical researches into evidence such as the above—notably in the epigraphic field—that the most trustworthy results have been worked out.

Take the case of Roman Britain. Had the lost books of Ammianus relating to Britain been preserved we might have had, in his rugged style, some partial sketch of the province as it existed in the age of its most complete Romanization. As it is, so far as historians are concerned, we are left in almost complete darkness. Here, again, it is through archeological research that light has penetrated, and thanks to the thoroughness and persistence of our own investigators, town sites such as Silchester in Roman Britain have been more completely uncovered than those of any other province.[3] Nor has any part of Britain supplied more important contributions in this field than the region of the Roman Wall, that great limitary work between the Solway and the mouth of the Tyne that once marked the northernmost European barrier of civilized dominion.

Speaking here, on the site of Hadrian's bridge-head station that formed its eastern key, it would be impossible for me not to pay a passing tribute, however inadequate, to the continuous work of exploration and research carried out by the Society of Antiquaries of Newcastle, now for over a hundred years in existence, worthily seconded by its sister society on the Cumbrian side, and of which the volumes of the respective *Proceedings* and *Transactions*, *Archæologia*, *Æliana*, and last but not least the *Lapidarium Septentrionale*, are

[2] "The Adriatic Slavs and the Overland Route to Constantinople," *Geographical Journal*, 1916, p. 241 seqq.

[3] See Haverfield, "Roman Britain in 1913," p. 86.

abiding records. The basis of methodical study was here the survey of the Wall carried out, together with that of its main military approach, the Watling Street, by MacLauchlan, under the auspices of Algernon, fourth Duke of Northumberland. And who, however lightly touching on such a theme, can overlook the services of the late Dr. Collingwood Bruce, the Grand Old Man, not only of the Wall itself, but of all pertaining to border antiquities, distinguished as an investigator for his scholarship and learning, whose lifelong devotion to his subject and contagious enthusiasm made the Roman Wall, as it had never been before, a household word?

New points of view have arisen, a stricter method and a greater subdivision of labor have become imperative in this as in other departments of research. We must, therefore, rejoice that local explorers have more and more availed themselves of the cooperation, and welcomed the guidance of those equipped with comparative knowledge drawn from other spheres. The British Vallum, it is now realized, must be looked at with perpetual reference to other frontier lines, such as the Germanic or the Rhætian lines; local remains of every kind have to be correlated with similar discoveries throughout the length and breadth of the Roman Empire.

This attitude in the investigation of the remains of Roman Britain—the promotion of which owes so much to the energy and experience of Professor Haverfield—has in recent years conducted excavation to specially valuable results. The work at Corbridge, the ancient Corstopitum, begun in 1906, and continued down to the autumn of 1914, has already uncovered throughout a great part of its area the largest urban center—civil as well as military in character—on the line of the Wall, and the principal store-base of its stations. Here, together with well-built granaries, workshops, and barracks, and such records of civic life as are supplied by sculptured stones and inscriptions, and the double discovery of hoards of gold coins, has come to light a spacious and massively constructed stone building, apparently a military storehouse, worthy to rank beside the bridge-piers of the North Tyne, among the most imposing monuments of Roman Britain. There is much here, indeed, to carry our thoughts far beyond our insular limits. On this, as on so many other sites along the Wall, the inscriptions and reliefs take us very far afield. We mark the grave-stone of a man of Palmyra, an altar of the Tyrian Hercules—its Phœnician Baal—a dedication to a pantheistic goddess of Syrian religion and the rayed effigy of the Persian Mithra. So, too, in the neighborhood of Newcastle itself, as elsewhere on the Wall, there was found an altar of Jupiter Dolichenus, the old Anatolian God of the Double Axe, the male form of the divinity once worshipped in the prehistoric Labyrinth of Crete. Nowhere are we more struck than in this remote extremity of the empire with the heterogeneous religious elements, often drawn from its far eastern borders, that before the days of the final advent of Christianity, Roman dominion had been instrumental in diffusing. The Orontes may be said to have flowed into the Tyne as well as the Tiber.

I have no pretension to follow up the various affluents merged in the later course of Greco-Roman civilization, as illustrated by these and similar discoveries throughout the Roman World. My own recent researches have been particularly concerned with the much more ancient cultural stage—that of prehistoric Crete—which leads up to the Greco-Roman, and which might seem to present the problem of origins at any rate in a less complex shape. The marvel-

lous Minoan civilization that has there come to light shows that Crete of four thousand years ago must unquestionably be regarded as the birth-place of our European civilization in its higher form.

But are we, even then, appreciably nearer to the fountain-head?

A new and far more remote vista has opened out in recent years, and it is not too much to say that a wholly new standpoint has been gained from which to survey the early history of the human race. The investigations of a brilliant band of prehistoric archeologists, with the aid of representatives of the sister sciences of geology and paleontology, have brought together such a mass of striking materials as to place the evolution of human art and appliances in the last Quaternary period on a far higher level than had even been suspected previously. Following in the footsteps of Lartet and after him Rivière and Piette, Professors Cartailhac, Captain, and Boule, the Abbé Breuil, Dr. Obermeier and their fellow investigators have revolutionized our knowledge of a phase of human culture which goes so far back beyond the limits of any continuous story, that it may well be said to belong to an older world.

To the engraved and sculptured works of man in the "Reindeer Period" we have now to add not only such new specialties as are exemplified by the moulded clay figures of life-size bisons in the Tuc d'Audoubert Cave, or the similar high reliefs of a procession of six horses cut on the overhanging limestone brow of Cap Blanc, but whole galleries of painted designs on the walls of caverns and rock shelters.

So astonishing was this last discovery, made first by the Spanish investigator Señor de Sautuola—or rather his little daughter—as long ago as 1878, that it was not till after it had been corroborated by repeated finds on the French side of the Pyrenees—not, indeed, till the beginning of the present century—that the Palæolithic Age of these rock paintings was generally recognized. In their most developed stage, as illustrated by the bulk of the figures in the Cave of Altamira itself, and in those of Marsoulas in the Haute Garonne, and of Font de Gaume in the Dordogne, these primeval frescoes display not only a consummate mastery of natural design but an extraordinary technical resource. Apart from the charcoal used in certain outlines, the chief coloring matter was red and yellow ochre, mortars and palettes for the preparation of which have come to light. In single animals the tints are varied from black to dark and ruddy brown or brilliant orange, and so, by fine gradations, to paler nuances, obtained by scraping and washing. Outlines and details are brought out by white incised lines, and the artists availed themselves with great skill of the reliefs afforded by convexities of the rock surface. But the greatest marvel of all is that such polychrome masterpieces as the bisons, standing and couchant, or with limbs huddled together, of the Altamira Cave, were executed on the ceilings of inner vaults and galleries where the light of day has never penetrated. Nowhere is there any trace of smoke, and it is clear that great progress in the art of artificial illumination had already been made. We now know that stone lamps, decorated in one case with the engraved head of an ibex, were already in existence.

Such was the level of artistic attainment in southwestern Europe, at a modest estimate some ten thousand years earlier than the most ancient monuments of Egypt or Chaldæa! Nor is this an isolated phenomenon. One by one, characteristics, both spiritual and material, that had been formerly thought to be the special marks of later ages of mankind have been shown to

go back to that earlier world. I myself can never forget the impression produced on me as a privileged spectator of a freshly uncovered interment in one of the Balzi Rossi Caves—an impression subsequently confirmed by other experiences of similar discoveries in these caves, which together first supplied the concordant testimony of an elaborate cult of the dead on the part of Aurignacian Man. Tall skeletons of the highly developed Cro-Magnon type lay beside or above their hearths, and protected by great stones from roving beasts. Flint knives and bone javelins had been placed within reach of their hands, chaplets and necklaces of sea-shells, fish-vertebræ, and studs of carved bone had decked their persons. With these had been set lumps of iron peroxide, the red stains of which appeared on skulls and bones, so that they might make a fitting show in the underworld.

> Colors, too, to paint his body,
> Place within his hand,
> That he glisten, bright and ruddy,
> In the Spirit-Land! [4]

Nor is it only in this cult of the departed that we trace the dawn of religious practises in that older world. At Cogul we may now survey the ritual dance of nine skirted women round a male satyr-like figure of short stature, while at Alpera a gowned sister ministrant holds up what has all the appearance of being a small idol. It can hardly be doubted that the small female images of ivory, steatite and crystalline talc from the same Aurignacian stratum as that of the Balzi Rossi interments, in which great prominence is given to the organs of maternity, had some fetichistic intention. So, too, many of the figures of animals engraved and painted on the inmost vaults of the caves may well have been due, as M. Salomon Reinach has suggested, to the magical ideas prompted by the desire to obtain a hold on the quarries of the chase that supplied the means of livelihood.

In a similar religious connection may be taken the growth of a whole family of signs, in some cases obviously derivatives of fuller pictorial originals, but not infrequently simplified to such a degree that they resemble or actually reproduce letters of the alphabet. Often they occur in groups like regular inscriptions, and it is not surprising that in some quarters they should have been regarded as evidence that the art of writing had already been evolved by the men of the Reindeer Age. A symbolic value certainly is to be attributed to these signs, and it must at least be admitted that by the close of the late Quaternary Age considerable advance had been made in hieroglyphic expression.

The evidences of more or less continuous civilized development reaching its apogee about the close of the Magdalenian Period have been constantly emerging from recent discoveries. The recurring "tectiform" sign had already clearly pointed to the existence of huts or wigwams; the "scutiform" and other types record appliances yet to be elucidated, and another sign well illustrated on a bone pendant from the Cave of St. Marcel has an unmistakable resemblance to a sledge.[5] But the most astonishing revelation of the cultural level already reached by primeval man has been supplied by the more recently discovered rock paintings of Spain. The area of discovery has now been extended there from the Province of Santander, where Altamira itself is situated, to the Valley of the Ebro, the Central Sierras, and to the extreme

[4] Schiller, "Nadowessier's Todtenlied."

[5] This interpretation suggested by me after inspecting the object in 1902 has been approved by the Abbé Breuil (*Anthropologie*, XIII., p. 152) and by Professor Sollas, "Ancient Hunters," 1915, p. 480.

southeastern region, including the Provinces of Albacete, Murcia and Almeria, and even to within the borders of Granada.

One after another, features that had been reckoned as the exclusive property of Neolithic or later Ages are thus seen to have been shared by Palæolithic Man in the final stage of his evolution. For the first time, moreover, we find the productions of his art rich in human subjects. At Cogul the sacral dance is performed by women clad from the waist downwards in well-cut gowns, while in a rock-shelter of Alpera,[6] where we meet with the same skirted ladies, their dress is supplemented by flying sashes. On the rock painting of the Cueva de la Vieja, near the same place, women are seen with still longer gowns rising to their bosoms. We are already a long way from Eve!

It is this great Alpera fresco which, among all those discovered, has afforded most new elements. Here are depicted whole scenes of the chase in which bowmen—up to the time of these last discoveries unknown among Palæolithic representations—take a leading part, though they had not as yet the use of quivers. Some are dancing in the attitude of the Australian Corroborees. Several wear plumed headdresses, and the attitudes at times are extraordinarily animated. What is specially remarkable is that some of the groups of these Spanish-rock paintings show dogs or jackals accompanying the hunters, so that the process of domesticating animals had already begun. Hafted axes are depicted as well as cunningly shaped throwing sticks. In one case at least we see two opposed bands of archers—marking at any rate a stage in social development in which organized warfare was possible—the beginnings, it is to be feared, of "Kultur" as well as of culture!

[6] That of Carasoles del Bosque; Breuil, *Anthropologie*, XXVI., 1915, p. 329 seqq.

Nor can there be any question as to the age of these scenes and figures, by themselves so suggestive of a much later phase of human history. They are inseparable from other elements of the same group, the animal and symbolic representations of which are shared by the contemporary school of rock-painting north of the Pyrenees. Some are overlaid by palimpsests, themselves of Palæolithic character. Among the animals actually depicted, moreover, the elk and bison distinctly belong to the Late Quaternary fauna of both regions, and are unknown there to the Neolithic deposits.

In its broader aspects this field of human culture, to which, on the European side, the name of Reindeer Age may still, on the whole, be applied, is now seen to have been very widespread. In Europe itself it permeates a large area—defined by the boundaries of glaciation—from Poland, and even a large Russian tract, to Bohemia, the upper course of the Danube and of the Rhine, to southwestern Britain and southeastern Spain. Beyond the Mediterranean, moreover, it fits on under varying conditions to a parallel form of culture, the remains of which are by no means confined to the Cis-Saharan zone, where incised figures occur of animals like the long-horned buffalo (*Bulbalus antiquus*) and others long extinct in that region. This southern branch may eventually be found to have a large extension. The nearest parallels to the finer class of rock-carvings as seen in the Dordogne are, in fact, to be found among the more ancient specimens of similar work in South Africa, while the rock-paintings of Spain find their best analogies among the Bushmen.

Glancing at this Late Quaternary culture, as a whole, in view of the materials supplied on the European side, it will not be superfluous for me to call attention to

two important points which some observers have shown a tendency to pass over.

Its successive phases, the Aurignacian, the Solutrean and the Magdalenian, with its decadent Azilian offshoot—the order of which may now be regarded as stratigraphically established—represent, on the whole, a continuous story.

I will not here discuss the question as to how far the disappearance of Neanderthal Man and the close of the Moustierian epoch represents a "fault" or gap. But the view that there was any real break in the course of the cultural history of the Reindeer Age itself does not seem to have sufficient warrant.

It is true that new elements came in from more than one direction. On the old Aurignacian area, which had a trans-Mediterranean extension from Syria to Morocco, there intruded on the European side—apparently from the east—the Solutrean type of culture, with its perfected flint-working and exquisite laurel-leaf points. Magdalenian man, on the other hand, great as the proficiency that he attained in the carving of horn and bone, was much behind in his flint-knapping. That there were dislocations and temporary set-backs is evident. But on every side we still note transitions and reminiscences. When, moreover, we turn to the most striking features of this whole cultural phase, the primeval arts of sculpture, engraving and painting, we see a gradual upgrowth and unbroken tradition. From mere outline figures and simple two-legged profiles of animals we are led on step by step to the full freedom of the Magdalenian artists. From isolated or disconnected subjects we watch the advance to large compositions, such as the hunting scenes of the Spanish rock-paintings. In the culminating phase of this art we even find impressionist works. A brilliant illustration of such is seen in the galloping herds of horses, lightly sketched by the engraver on the stone slab from the Chaumont Grotto, depicting the leader in each case in front of his troop, and its serried line—straight as that of a well-drilled battalion—in perspective rendering. The whole must be taken to be a faithful memory sketch of an exciting episode of prairie life.

The other characteristic feature of the culture of the Reindeer age that seems to deserve special emphasis, and is almost the corollary of the foregoing, is that it can not be regarded as the property of a single race. It is true that the finely built Cro-Magnon race seems to have predominated, and must be regarded as an element of continuity throughout, but the evidence of the co-existence of other human types is clear. Of the physical characteristics of these it is not my province to speak. Here it will be sufficient to point out that their interments, as well as their general associations, conclusively show that they shared, even in its details, the common culture of the age, followed the same fashions, plied the same arts, and were imbued with the same beliefs as the Cro-Magnon folk. The negroid skeletons intercalated in the interesting succession of hearths and interments of the Grotte des Enfants at Grimaldi had been buried with the same rites, decked with the same shell ornaments, and were supplied with the same red coloring matter for use in the spirit world, as we find in the other sepultures of these caves belonging to the Cro-Magnon race. Similar burial rites were associated in this country with the "Red Lady of Paviland," the contemporary Aurignacian date of which is now well established. A like identity of funeral custom recurred again in the sepulture of a man of the "Brünn" race on the eastern boundary of this field of culture.

In other words, the conditions prevailing were analogous to those of modern Europe. Cultural features of the same general char-

acter had imposed themselves on a heterogeneous population. That there was a considerable amount of circulation, indeed—if not of primitive commerce—among the peoples of the Reindeer Age is shown by the diffusion of shell or fossil ornaments derived from the Atlantic, the Mediterranean or from inland geological strata. Art itself is less the property of one or another race than has sometimes been imagined—indeed, if we compare those products of the modern carver's art that have most analogy with the horn and bone carvings of the Cave Men and rise at times to great excellence—as we see them, for instance, in Switzerland or Norway—they are often the work of races of very different physical types. The negroid contributions, at least in the southern zone of this Late Quaternary field, must not be underestimated. The early steatopygous[6] images—such as some of these of the Balzi Rossi caves—may safely be regarded as due to this ethnic type, which is also pictorially represented in some of the Spanish rock-paintings.

The nascent flame of primeval culture was thus already kindled in that older world, and, so far as our present knowledge goes, it was in the southwestern part of our continent, on either side of the Pyrenees, that it shone its brightest. After the great strides in human progress already made at that remote epoch, it is hard, indeed, to understand what it was that still delayed the rise of European civilization in its higher shape. Yet it had to wait for its fulfilment through many millennia. The gathering shadows thickened and the darkness of a long night fell not on that favored region alone, but throughout the wide area where Reindeer Man had ranged. Still the question rises—as yet imperfectly answered—were there no relay runners to pass on elsewhere the lighted torch?

Something, indeed, has been recently done towards bridging over the "hiatus" that formerly separated the Neolithic from the Palæolithic Age—the yawning gulf between two worlds of human existence. The Azilian—a later decadent outgrowth of the preceding culture—which is now seen partially to fill the lacuna, seems to be in some respects an impoverished survival of the Aurignacian.[7] The existence of this phase was first established by the long and patient investigations of Piette in the stratified deposits of the cave of Mas d'Azil in the Ariège, from which it derives its name, and it has been proved by recent discoveries to have had a wide extension. It affords evidence of a milder and moister climate—well illustrated by the abundance of the little wood snail (*helix nemoralis*) and the increasing tendency of the reindeer to die out in the southern parts of the area, so that in the fabric of the characteristic harpoons deer-horns are used as substitutes. Artistic designs now fail us, but the polychrome technique of the preceding age still survives in certain schematic and geometric figures, and in curious colored signs on pebbles. These last first came to light in the cave of Mas d'Azil, but they have now been found to recur much further afield in a similar association in grottoes from the neighborhood of Basel to that of Salamanca. So like letters are some of these signs that the lively imagination of Piette saw in them the actual characters of a primeval alphabet!

The little flakes with a worked edge often known as "pygmy flints," which were most of them designed for insertion into bone or horn harpoons, like some Neolithic examples, are very characteristic of this stratum, which is widely diffused in France and elsewhere under the misleading name of "Tardenoisian." At Ofnet, in Bavaria, it is associated with a ceremonial skull

[7] Breuil, "Congr. Préhist.," Geneva, 1912, p. 216.

burial showing the coexistence at that spot of brachycephalic and dolichocephalic types, both of a new character. In Britain, as we know, this Azilian, or a closely allied phase, is traceable as far north as the Oban Caves.

What, however, is of special interest is the existence of a northern parallel to this cultural phase, first ascertained by the Danish investigator, Dr. Sarauw, in the lake station of Maglemose, near the west coast of Zealand. Here bone harpoons of the Azilian type occur, with bone and horn implements showing geometrical and rude animal engravings of a character divergent from the Magdalenian tradition. The settlement took place when what is now the Baltic was still the great "Ancylus Lake," and the waters of the North Sea had not yet burst into it. It belongs to the period of the Danish pine and birch woods, and is shown to be anterior to the earliest shell mounds of the Kitchenmidden people, when the pine and the birch had given place to the oak. Similar deposits extend to Sweden and Norway, and to the Baltic provinces as far as the Gulf of Finland. The parallel relationship of this culture is clear, and its remains are often accompanied with the characteristic "pygmy" flints. Breuil, however,[8] while admitting the late Palæolithic character of this northern branch, would bring it into relation with a vast Siberian and Altaic province, distinguished by the widespread existence of rock-carvings of animals. It is interesting to note that a rock-engraving of a reindeer, very well stylized, from the Trondhjem Fjord, which has been referred to the Maglemosian phase, preserves the simple profile rendering—two legs only being visible—of Early Aurignacian tradition.

[8] "Les subdivisions du paléolithique supérieur et leur signification." Congrès intern. d'Anthrop. et d'Archéol. préhist., XIV^me Sess., Genève, 1912, pp. 165, 238.

It is worth noting that an art affiliated to that of the petroglyphs of the old Altaic region long survived in the figures of the Lapp trolldrums, and still occasionally lingers, as I have myself had occasion to observe, on the reindeer-horn spoons of the Finnish and Russian Lapps, whose ethnic relationship, moreover, points east of the Urals. The existence of a Late Palæolithic Province on the Russian side is in any case now well recognized and itself supports the idea of a later shifting north and northeast, just as at a former period it had oscillated in a southwestern direction. All this must be regarded as corroborating the view long ago expressed by Boyd Dawkins[9] that some part of the old cave race may still be represented by the modern Eskimos. Testut's comparison of the short-statured Magdalenian skeleton from the rock shelter of Chancelade in the Dordogne with that of an Eskimo certainly confirms this conclusion.

On the other hand, the evidence, already referred to, of an extension of the Late Palæolithic culture to a North African zone, including rock-sculptures depicting a series of animals extinct there in the later age, may be taken to favor the idea of a partial continuation on that side. Some of the early rock-sculptures in the south of the continent, such as the figure of a walking elephant reproduced by Dr. Peringuey, afford the clearest existing parallels to the best Magdalenian examples. There is much, indeed, to be said for the view, of which Sollas is an exponent, that the bushmen, who at a more recent date entered that region from the north, and whose rock-painting attained such a high level of naturalistic art, may themselves be taken as later representatives of the same tradition. In their human figures the resemblances descend even to conventional details, such as we meet with at Cogul and Alpera.

[9] "Early Man in Britain," 1880, p. 233 seqq.

Once more, we must never lose sight of the fact that from the Early Aurignacian Period onwards a negroid element in the broadest sense of the word shared in this artistic culture as seen on both sides of the Pyrenees.

At least we now know that cave man did not suffer any sudden extinction, though on the European side, partly, perhaps, owing to the new climatic conditions, this culture underwent a marked degeneration. It may well be that, as the osteological evidence seems to imply, some outgrowth of the old Cro-Magnon type actually perpetuated itself in the Dordogne. We have certainly lengthened our knowledge of the Palæolithic. But in the present state of the evidence it seems better to subscribe to Cartailhac's view that its junction with the Neolithic has not yet been reached. There does not seem to be any real continuity between the culture revealed at Maglemose and that of the immediately superposed Early Neolithic stratum of the shell-mounds, which, moreover, as has been already said, evidence a change both in climatic and geological conditions, implying a considerable interval of time.

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(*To be continued*)

THE ORGANIZATION OF THOUGHT[1]

The subject of this address is the organization of thought, a topic evidently capable of many diverse modes of treatment. I intend more particularly to give some account of that department of logical science with which some of my own studies have been connected. But I am anxious, if I can succeed in so doing, to handle this account so as to exhibit the relation with certain considerations which underlie general scientific activities.

It is no accident that an age of science has developed into an age of organization. Organized thought is the basis of organized action. Organization is the adjustment of diverse elements so that their mutual relations may exhibit some predetermined quality. An epic poem is a triumph of organization, that is to say, it is a triumph in the unlikely event of it being a good epic poem. It is the successful organization of multitudinous sounds of words, associations of words, pictorial memories of diverse events and feelings ordinarily occurring in life, combined with a special narrative of great events: the whole so disposed as to excite emotions which, as defined by Milton, are simple, sensuous and passionate. The number of successful epic poems is commensurate, or rather, is inversely commensurate with the obvious difficulty of the task of organization.

Science is the organization of thought. But the example of the epic poem warns us that science is not any organization of thought. It is an organization of a certain definite type which we will endeavor to determine.

Science is a river with two sources, the practical source and the theoretical source. The practical source is the desire to direct our actions to achieve predetermined ends. For example, the British nation, fighting for justice, turns to science, which teaches it the importance of compounds of nitrogen. The theoretical source is the desire to understand. Now I am going to emphasize the importance of theory in science. But to avoid misconception I most emphatically state that I do not consider one source as in any sense nobler than the other, or intrinsically more interesting. I can not see why it is nobler to strive to understand than to busy oneself with the right ordering of one's

[1] Address of the president of the Mathematical and Physical Science Section, British Association for the Advancement of Science, Newcastle-on-Tyne, 1916.

actions. Both have their bad sides; there are evil ends directing actions, and there are ignoble curiosities of the understanding.

The importance, even in practise, of the theoretical side of science arises from the fact that action must be immediate, and takes place under circumstances which are excessively complicated. If we wait for the necessities of action before we commence to arrange our ideas, in peace we shall have lost our trade, and in war we shall have lost the battle.

Success in practise depends on theorists who, led by other motives of exploration, have been there before, and by some good chance have hit upon the relevant ideas. By a theorist I do not mean a man who is up in the clouds, but a man whose motive for thought is the desire to formulate correctly the rules according to which events occur. A successful theorist should be excessively interested in immediate events, otherwise he is not at all likely to formulate correctly anything about them. Of course, both sources of science exist in all men.

Now, what is this thought organization which we call science? The first aspect of modern science which struck thoughtful observers was its inductive character. The nature of induction, its importance, and the rules of inductive logic have been considered by a long series of thinkers, especially English thinkers, Bacon, Herschel, J. S. Mill, Venn, Jevons and others. I am not going to plunge into an analysis of the process of induction. Induction is the machinery and not the product, and it is the product which I want to consider. When we understand the product we shall be in a stronger position to improve the machinery.

First, there is one point which it is necessary to emphasize. There is a tendency in analyzing scientific processes to assume a given assemblage of concepts applying to nature, and to imagine that the discovery of laws of nature consists in selecting by means of inductive logic some one out of a definite set of possible alternative relations which may hold between the things in nature answering to these obvious concepts. In a sense this assumption is fairly correct, especially in regard to the earlier stages of science. Mankind found itself in possession of certain concepts respecting nature—for example, the concept of fairly permanent material bodies—and proceeded to determine laws which related the corresponding percepts in nature. But the formulation of laws changed the concepts, sometimes gently by an added precision, sometimes violently. At first this process was not much noticed, or at least was felt to be a process curbed within narrow bounds, not touching fundamental ideas. At the stage where we now are, the formulation of the concepts can be seen to be as important as the formulation of the empirical laws connecting the events in the universe as thus conceived by us. For example, the concepts of life, of heredity, of a material body, of a molecule, of an atom, of an electron, of energy, of space, of time, of quantity, and of number. I am not dogmatizing about the best way of getting such ideas straight. Certainly it will only be done by those who have devoted themselves to a special study of the facts in question. Success is never absolute, and progress in the right direction is the result of a slow, gradual process of continual comparison of ideas with facts. The criterion of success is that we should be able to formulate empirical laws, that is, statements of relations, connecting the various parts of the universe as thus conceived, laws with the property that we can interpret the actual events of our lives as being our fragmentary knowledge of this conceived interrelated whole.

But, for the purposes of science, what is the actual world? Has science to wait for the termination of the metaphysical debate till it can determine its own subject-matter? I suggest that science has a much more homely starting-ground. Its task is the discovery of the relations which exist within that flux of perceptions, sensations and emotions which forms our experience of life. The panorama yielded by sight, sound, taste, smell, touch and by more inchoate sensible feelings, is the sole field of its activity. It is in this way that science is the thought organization of experience. The most obvious aspect of this field of actual experience is its disorderly character. It is for each person a *continuum*, fragmentary, and with elements not clearly differentiated. The comparison of the sensible experiences of diverse people brings its own difficulties. I insist on the radically untidy, ill-adjusted character of the fields of actual experience from which science starts. To grasp this fundamental truth is the first step in wisdom, when constructing a philosophy of science. This fact is concealed by the influence of language, moulded by science, which foists on us exact concepts as though they represented the immediate deliverances of experience. The result is that we imagine that we have immediate experience of a world of perfectly defined objects implicated in perfectly defined events which, as known to us by the direct deliverance of our senses, happen at exact instants of time, in a space formed by exact points, without parts and without magnitude: the neat, trim, tidy, exact world which is the goal of scientific thought.

My contention is that this world is a world of ideas, and that its internal relations are relations between abstract concepts, and that the elucidation of the precise connection between this world and the feelings of actual experience is the fundamental question of scientific philosophy. The question which I am inviting you to consider is this: How does exact thought apply to the fragmentary, vague *continua* of experience? I am not saying that it does not apply, quite the contrary. But I want to know how it applies. The solution I am asking for is not a phrase, however brilliant, but a solid branch of science, constructed with slow patience, showing in detail how the correspondence is effected.

The first great steps in the organization of thought were due exclusively to the practical source of scientific activity, without any admixture of theoretical impulse. Their slow accomplishment was the cause and also the effect of the gradual evolution of moderately rational beings. I mean the formation of the concepts of definite material objects, of the determinate lapse of time, of simultaneity, of recurrence, of definite relative position, and of analogous fundamental ideas, according to which the flux of our experiences is mentally arranged for handy reference: in fact, the whole apparatus of common-sense thought. Consider in your mind some definite chair. The concept of that chair is simply the concept of all the interrelated experiences connected with that chair—namely, of the experiences of the folk who made it, of the folk who sold it, of the folk who have seen it, or used it, of the man who is now experiencing a comfortable sense of support, combined with our expectations of an analogous future, terminated finally by a different set of experiences when the chair collapses and becomes fire-wood. The formation of that type of concept was a tremendous job, and zoologists and geologists tell us that it took many tens of millions of years. I can well believe it.

I now emphasize two points. In the first

place, science is rooted in what I have just called the whole apparatus of common-sense thought. That is the *datum* from which it starts, and to which it must recur. We may speculate, if it amuses us, of other beings in other planets who have arranged analogous experiences according to an entirely different conceptual code—namely, who have directed their chief attention to different relations between their various experiences. But the task is too complex, too gigantic, to be revised in its main outlines. You may polish up common sense, you may contradict it in detail, you may surprise it. But ultimately your whole task is to satisfy it.

In the second place, neither common sense nor science can proceed with their task of thought organization without departing in some respect from the strict consideration of what is actual in experience. Think again of the chair. Among the experiences upon which its concept is based, I included our expectations of its future history. I should have gone further and included our imagination of all the possible experiences which in ordinary language we should call perceptions of the chair which might have occurred. This is a difficult question, and I do not see my way through it. But at present in the construction of a theory of space and of time, there seem insuperable difficulties if we refuse to admit ideal experiences.

This imaginative perception of experiences, which, if they occurred, would be coherent with our actual experiences, seems fundamental in our lives. It is neither wholly arbitrary, nor yet fully determined. It is a vague background which is only made in part definite by isolated activities of thought. Consider, for example, our thoughts of the unseen flora of Brazil.

Ideal experiences are closely connected with our imaginative reproduction of the actual experiences of other people, and also with our almost inevitable conception of ourselves as receiving our impressions from an external complex reality beyond ourselves. It may be that an adequate analysis of every source and every type of experience yields demonstrative proof of such a reality and of its nature. Indeed, it is hardly to be doubted that this is the case. The precise elucidation of this question is the problem of metaphysics. One of the points which I am urging in this address is that the basis of science does not depend on the assumption of any of the conclusions of metaphysics; but that both science and metaphysics start from the same given groundwork of immediate experience, and in the main proceed in opposite directions on their diverse tasks.

For example, metaphysics inquires how our perceptions of the chair relate us to some true reality. Science gathers up these perceptions into a determinate class, adds to them ideal perceptions of analogous sort, which under assignable circumstances would be obtained, and this single concept of that set of perceptions is all that science needs; unless indeed you prefer that thought find its origin in some legend of those great twin brethren, the cock and bull.

My immediate problem is to inquire into the nature of the texture of science. Science is essentially logical. The nexus between its concepts is a logical nexus, and the grounds for its detailed assertions are logical grounds. King James said, "No bishops, no king." With greater confidence we can say, "No logic, no science." The reason for the instinctive dislike which most men of science feel towards the recognition of this truth is, I think, the barren failure of logical theory during the past three or four centuries. We may trace this failure back to the worship of authority

which in some respects increased in the learned world at the time of the Renaissance. Mankind then changed its authority, and this fact temporarily acted as an emancipation. But the main fact, and we can find complaints[2] of it at the very commencement of the modern movement, was the establishment of a reverential attitude towards any statement made by a classical author. Scholars became commentators on truths too fragile to bear translation. A science which hesitates to forget its founders is lost. To this hesitation I ascribe the barrenness of logic. Another reason for distrust of logical theory and of mathematics is the belief that deductive reasoning can give you nothing new. Your conclusions are contained in your premises, which by hypothesis are known to you.

In the first place this last condemnation of logic neglects the fragmentary, disconnected character of human knowledge. To know one premise on Monday, and another premise on Tuesday, is useless to you on Wednesday. Science is a permanent record of premises, deductions and conclusions, verified all along the line by its correspondence with facts. Secondly, it is untrue that when we know the premises we also know the conclusions. In arithmetic, for example, mankind are not calculating boys. Any theory which proves that they are conversant with the consequences of their assumptions must be wrong. We can imagine beings who possess such insight. But we are not such creatures. Both these answers are, I think, true and relevant. But they are not satisfactory. They are too much in the nature of bludgeons, too external. We want something more explanatory of the very real difficulty which the question suggests. In fact, the true answer is embedded in the discussion of our main problem of the relation of logic to natural science.

[2] *E. g.*, in 1551 by Italian schoolmen.

It will be necessary to sketch in broad outline some relevant features of modern logic. In doing so I shall try to avoid the profound general discussions and the minute technical classifications which occupy the main part of traditional logic. It is characteristic of a science in its earlier stages—and logic has become fossilized in such a stage—to be both ambitiously profound in its aims and trivial in its handling of details. We can discern four departments of logical theory. By an analogy which is not so very remote I will call these departments or sections the arithmetic section, the algebraic section, the section of general-function theory, the analytic section. I do not mean that arithmetic arises in the first section, algebra in the second section, and so on; but the names are suggestive of certain qualities of thought in each section which are reminiscent of analogous qualities in arithmetic, in algebra, in the general theory of a mathematical function, and in the analysis of the properties of particular functions.

The first section—namely, the arithmetic stage—deals with the relations of definite propositions to each other, just as arithmetic deals with definite numbers. Consider any definite proposition; call it "*p*." We conceive that there is always another proposition which is the direct contradictory to "*p*"; call it "not-*p*." When we have got two propositions, *p* and *q*, we can form derivative propositions from them, and from their contradictories. We can say, "At least one of *p* or *q* is true, and perhaps both." Let us call this proposition "*p* or *q*." I may mention as an aside that one of the greatest living philosophers has stated that this use of the word "or"—namely, "*p* or *q*" in the sense that either or both may be true—makes him despair of

exact expression. We must brave his wrath, which is unintelligible to me.

We have thus got hold of four new propositions, namely, "p or q," and "not-p or q," and "p or not-q," and "not-p or not-q." Call these the set of disjunctive derivatives. There are, so far, in all eight propositions p, not-p, q, not-q, and the four disjunctive derivatives. Any pair of these eight propositions can be taken, and substituted for p and q in the foregoing treatment. Thus each pair yields eight propositions, some of which may have been obtained before. By proceeding in this way we arrive at an unending set of propositions of growing complexity, ultimately derived from the two original propositions p or q. Of course, only a few are important. Similarly we can start from three propositions, p, q, r, or from four propositions, p, q, r, s, and so on. Any one of the propositions of these aggregates may be true or false. It has no other alternative. Whichever it is, true or false, call it the "truth-value" of the proposition.

The first section of logical inquiry is to settle what we know of the truth-values of these propositions, when we know the truth-values of some of them. The inquiry, so far as it is worth while carrying it, is not very abstruse, and the best way of expressing its results is a detail which I will not now consider. This inquiry forms the arithmetic stage.

The next section of logic is the algebraic stage. Now, the difference between arithmetic and algebra is that in arithmetic definite numbers are considered, and in algebra symbols—namely, letters—are introduced which stand for any numbers. The idea of a number is also enlarged. These letters, standing for any numbers, are called sometimes variables and sometimes parameters. Their essential characteristic is that they are undetermined, unless, indeed, the algebraic conditions which they satisfy implicitly determine them. Then they are sometimes called unknowns. An algebraic formula with letters is a blank form. It becomes a determinate arithmetic statement when definite numbers are substituted for the letters. The importance of algebra is a tribute to the study of form. Consider now the following proposition,

The specific heat of mercury is 0.033.

This is a definite proposition which, with certain limitations, is true. But the truth-value of the proposition does not immediately concern us. Instead of mercury put a mere letter which is the name of some undetermined thing: we get

The specific heat of x is 0.033.

This is not a proposition; it has been called by Russell a propositional function. It is the logical analogy of an algebraic expression. Let us write $f(x)$ for any propositional function.

We could also generalize still further, and say

The specific heat of x is y.

We thus get another propositional function, $F(x, y)$ of two arguments x and y, and so on for any number of arguments.

Now, consider $f(x)$. There is the range of values of x, for which $f(x)$ is a proposition, true or false. For values of x outside this range, $f(x)$ is not a proposition at all, and is neither true nor false. It may have vague suggestions for us, but it has no unit meaning of definite assertion. For example,

The specific heat of water is 0.033

is a proposition which is false; and

The specific heat of virtue is 0.033

is, I should imagine, not a proposition at all; so that it is neither true nor false, though its component parts raise various associations in our minds. This range of values, for which $f(x)$ has sense, is called the "type" of the argument x.

But there is also a range of values of x for which $f(x)$ is a true proposition. This is the class of those values of the argument which *satisfy* $f(x)$. This class may have no members, or, in the other extreme, the class may be the whole type of the arguments.

We thus conceive two general propositions respecting the indefinite number of propositions which share in the same logical form, that is, which are values of the same propositional function. One of these propositions is

$f(x)$ yields a true proposition for each value of x of the proper type;

the other proposition is

There is a value of x for which $f(x)$ is true.

Given two, or more, propositional functions $f(x)$ and $\phi(x)$ with the same argument x, we form derivative propositional functions, namely,

$$f(x) \text{ or } \phi(x),\ f(x) \text{ or not-}\phi(x),$$

and so on with the contradictories, obtaining, as in the arithmetical stage, an unending aggregate of propositional functions. Also each propositional function yields two general propositions. The theory of the interconnection between the truth-values of the general propositions arising from any such aggregate of propositional functions forms a simple and elegant chapter of mathematical logic.

In this algebraic section of logic the theory of types crops up, as we have already noted. It can not be neglected without the introduction of error. Its theory has to be settled at least by some safe hypothesis, even if it does not go to the philosophic basis of the question. This part of the subject is obscure and difficult, and has not been finally elucidated, though Russell's brilliant work has opened out the subject.

The final impulse to modern logic comes from the independent discovery of the importance of the logical variable by Frege and Peano. Frege went further than Peano, but by an unfortunate symbolism rendered his work so obscure that no one fully recognized his meaning who had not found it out for himself. But the movement has a large history reaching back to Leibniz and even to Aristotle. Among English contributors are De Morgan, Boole and Sir Alfred Kempe; their work is of the first rank.

The third logical section is the stage of general-function theory. In logical language, we perform in this stage the transition from intension to extension, and investigate the theory of denotation. Take the propositional function $f(x)$. There is the class, or range of values for x, whose members satisfy $f(x)$. But the same range may be the class whose members satisfy another propositional function $\phi(x)$. It is necessary to investigate how to indicate the class by a way which is indifferent as between the various propositional functions which are satisfied by any member of it, and of it only. What has to be done is to analyze the nature of propositions about a class—namely, those propositions whose truth-values depend on the class itself and not on the particular meaning by which the class is indicated.

Furthermore, there are propositions about alleged individuals indicated by descriptive phrases: for example, propositions about "the present King of England," who does exist, and "the present Emperor of Brazil," who does not exist. More complicated, but analogous, questions involving propositional functions of two variables involve the notion of "correlation," just as functions of one argument involve classes. Similarly functions of three arguments yield three-cornered correlations, and so on. This logical section is one which Russell has made peculiarly his own by work which must always remain fundamental. I have

called this the section of functional theory, because its ideas are essential to the construction of logical denoting functions which include as a special case ordinary mathematical functions such as sine, logarithm, etc. In each of these three stages it will be necessary gradually to introduce an appropriate symbolism, if we are to pass on to the fourth stage.

The fourth logical section, the analytic stage, is concerned with the investigation of the properties of special logical constructions, that is, of classes and correlations of special sorts. The whole of mathematics is included here. So the section is a large one. In fact, it is mathematics, neither more nor less. But it includes an analysis of mathematical ideas not hitherto included in the scope of that science, nor, indeed, contemplated at all. The essence of this stage is construction. It is by means of suitable constructions that the great framework of applied mathematics, comprising the theories of number, quantity, time and space, is elaborated.

It is impossible even in brief outline to explain how mathematics is developed from the concepts of class and correlation, including many-cornered correlations, which are established in the third section. I can only allude to the headings of the process which is fully developed in the work, "Mathematica Principia," by Mr. Russell and myself. There are in this process of development seven special sorts of correlations which are of peculiar interest. The first sort comprises one-to-many, many-to-one, and one-to-one correlations. The second sort comprises serial relations, that is, correlations by which the members of some field are arranged in a serial order, so that, in the sense defined by the relation, any member of the field is either before or after any other member. The third class comprises inductive relations, that is, correlations on which the theory of mathematical induction depends. The fourth class comprises selective relations, which are required for the general theory of arithmetic operations, and elsewhere. It is in connection with such relations that the famous multiplicative axiom arises for consideration. The fifth class comprises vector relations, from which the theory of quantity arises. The sixth class comprises ratio relations, which interconnect number and quantity. The seventh class comprises three-cornered and four-cornered relations which occur in geometry.

A bare enumeration of technical names, such as the above, is not very illuminating, though it may help to a comprehension of the demarcations of the subject. Please remember that the names are technical names, meant, no doubt, to be suggestive, but used in strictly defined senses. We have suffered much from critics who consider it sufficient to criticize our procedure on the slender basis of a knowledge of the dictionary meanings of such terms. For example, a one-to-one correlation depends on the notion of a class with only one member, and this notion is defined without appeal to the concept of the number one. The notion of diversity is all that is wanted. Thus the class α has only one member, if (1) the class of values of x which satisfies the propositional function,

x is not a member of α,

is not the whole type of relevant values of x, and (2) the propositional function,

x and y are members of α, and
x is diverse from y,

is false whatever be the values of x and y in the relevant type.

Analogous procedures are obviously possible for higher finite cardinal members. Thus, step by step, the whole cycle of current mathematical ideas is capable of logical definition. The process is detailed and laborious, and, like all science, knows noth-

ing of a royal road of airy phrases. The essence of the process is, first to construct the notion in terms of the forms of propositions, that is, in terms of the relevant propositional functions, and secondly to prove the fundamental truths which hold about the notion by reference to the results obtained in the algebraic section of logic.

It will be seen that in this process the whole apparatus of special indefinable mathematical concepts, and special *a priori* mathematical premises, respecting number, quantity and space, has vanished. Mathematics is merely an apparatus for analyzing the deductions which can be drawn from any particular premises, supplied by common sense, or by more refined scientific observation, so far as these deductions depend on the forms of the propositions. Propositions of certain forms are continually occurring in thought. Our existing mathematics is the analysis of deductions, which concern those forms and in some way are important, either from practical utility or theoretical interest. Here I am speaking of the science as it in fact exists. A theoretical definition of mathematics must include in its scope any deductions depending on the mere forms of propositions. But, of course, no one would wish to develop that part of mathematics which in no sense is of importance.

This hasty summary of logical ideas suggests some reflections. The question arises, How many forms of propositions are there? The answer is: An unending number. The reason for the supposed sterility of logical science can thus be discerned. Aristotle founded the science by conceiving the idea of the form of a proposition, and by conceiving deduction as taking place in virtue of the forms. But he confined propositions to four forms, now named A, I, E, O. So long as logicians were obsessed by this unfortunate restriction, real progress was impossible. Again, in their theory of form, both Aristotle and subsequent logicians came very near to the theory of the logical variable. But to come very near to a true theory, and to grasp its precise application, are two very different things, as the history of science teaches us. Everything of importance has been said before by somebody who did not discover it.

Again, one reason why logical deductions are not obvious is that logical form is not a subject which ordinarily enters into thought. Common-sense deduction probably moves by blind instinct from concrete proposition to concrete proposition, guided by some habitual association of ideas. Thus common sense fails in the presence of a wealth of material.

A more important question is the relation of induction, based on observation, to deductive logic. There is a tradition of opposition between adherents of induction and of deduction. In my view, it would be just as sensible for the two ends of a worm to quarrel. Both observation and deduction are necessary for any knowledge worth having. We can not get an inductive law without having recourse to a propositional function. For example, take the statement of observed fact,

This body is mercury, and its specific heat is 0.033.

The propositional function is formed,

Either x is not mercury, or its specific heat is 0.033.

The inductive law is the assumption of the truth of the general proposition, that the above propositional function is true for every value of x in the relevant type.

But it is objected that this process and its consequences are so simple that an elaborate science is out of place. In the same way, a British sailor knows the salt sea when he sails over it. What, then, is the use of an elaborate chemical analysis of sea-water? There is the general answer, that you can not know too much of meth-

ods which you always employ; and there is the special answer, that logical forms and logical implications are not so very simple, and that the whole of mathematics is evidence to this effect.

One great use of the study of logical method is not in the region of elaborate deduction, but to guide us in the study of the formation of the main concepts of science. Consider geometry, for example. What are the points which compose space? Euclid tells us that they are without parts and without magnitude. But how is the notion of a point derived from the sense-perceptions from which science starts? Certainly points are not direct deliverances of the senses. Here and there we may see or unpleasantly feel something suggestive of a point. But this is a rare phenomenon, and certainly does not warrant the conception of space as composed of points. Our knowledge of space properties is not based on any observations of relations between points. It arises from experience of relations between bodies. Now a fundamental space relation between bodies is that one body may be part of another. We are tempted to define the "whole and part" relation by saying that the points occupied by the part are some of the points occupied by the whole. But "whole and part" being more fundamental than the notion of "point," this definition is really circular and vicious.

We accordingly ask whether any other definition of "spatial whole and part" can be given. I think that it can be done in this way, though, if I be mistaken, it is unessential to my general argument. We have come to the conclusion that an extended body is nothing else than the class of perceptions of it by all its percipients, actual or ideal. Of course, it is not any class of perceptions, but a certain definite sort of class which I have not defined here, except by the vicious method of saying that they are perceptions of a body. Now, the perceptions of a part of a body are among the perceptions which compose the whole body. Thus two bodies a and b are both classes of perceptions; and b is part of a when the class which is b is contained in the class which is a. It immediately follows from the logical form of this definition that if b is part of a, and c is part of b, then c is part of a. Thus the relation "whole to part" is transitive. Again, it will be convenient to allow that a body is part of itself. This is a mere question of how you draw the definition. With this understanding, the relation is reflexive. Finally, if a is part of b, and b is part of a, then a and b must be identical. These properties of "whole and part" are not fresh assumptions, they follow from the logical form of our definition.

One assumption has to be made if we assume the ideal infinite divisibility of space. Namely, we assume that every class of perceptions which is an extended body contains other classes of perceptions which are extended bodies diverse from itself. This assumption makes rather a large draft on the theory of ideal perceptions. Geometry vanishes unless in some form you make it. The assumption is not peculiar to my exposition.

It is then possible to define what we mean by a point. A point is the class of extended objects which, in ordinary language, contain that point. The definition, without presupposing the idea of a point, is rather elaborate, and I have not now time for its statement.

The advantage of introducing points into geometry is the simplicity of the logical expression of their mutual relations. For science, simplicity of definition is of slight importance, but simplicity of mutual relations is essential. Another example of this law is the way physicists and chemists

have dissolved the simple idea of an extended body, say of a chair, which a child understands, into a bewildering notion of a complex dance of molecules and atoms and electrons and waves of light. They have thereby gained notions with simpler logical relations.

Space as thus conceived is the exact formulation of the properties of the apparent space of the common-sense world of experience. It is not necessarily the best mode of conceiving the space of the physicist. The one essential requisite is that the correspondence between the common-sense world in its space and the physicists' world in its space should be definite and reciprocal.

I will now break off the exposition of the function of logic in connection with the science of natural phenomena. I have endeavored to exhibit it as the organizing principle, analyzing the derivation of the concepts from the immediate phenomena, examining the structure of the general propositions which are the assumed laws of nature, establishing their relations to each other in respect to reciprocal implications, deducing the phenomena we may expect under given circumstances.

Logic, properly used, does not shackle thought. It gives freedom and, above all, boldness. Illogical thought hesitates to draw conclusions, because it never knows either what it means, or what it assumes, or how far it trusts its own assumptions, or what will be the effect of any modification of assumptions. Also the mind untrained in that part of constructive logic which is relevant to the subject in hand will be ignorant of the sort of conclusions which follow from various sorts of assumptions, and will be correspondingly dull in divining the inductive laws. The fundamental training in this relevant logic is, undoubtedly, to ponder with an active mind over the known facts of the case, directly observed. But where elaborate deductions are possible, this mental activity requires for its full exercise the direct study of the abstract logical relations. This is applied mathematics.

Neither logic without observation, nor observation without logic, can move one step in the formation of science. We may conceive humanity as engaged in an internecine conflict between youth and age. Youth is not defined by years, but by the creative impulse to make something. The aged are those who, before all things, desire not to make a mistake. Logic is the olive branch from the old to the young, the wand which in the hands of youth has the magic property of creating science.

A. N. WHITEHEAD

DR. HALDANE'S SILLIMAN LECTURES

DR. J. S. HALDANE, of the University of Oxford, gives the Silliman lectures at Yale University on October 9, 10, 12 and 13. The general subject of the lectures is: Organization and Environment as illustrated by the Physiology of Breathing. The topics of the separate lectures are:

Lecture I.—The problem presented by the coordinated maintenance of reactions between organism and environment—vitalistic and mechanistic attempts at explanation; The elementary facts relating to breathing; The respiratory center and the blood; Alveolar air and the exact regulation of its CO_2 percentage; Apnea and hyperpnea; Varying frequency of breathing; Physiological effects of varying pressures of gases; Effects of deprivation of CO_2; Effects of air of confined spaces and mines; Effects of compressed air in diving; Influence of the vagus nerves in breathing; Coordination of the responses to central and peripheral nervous stimuli, so that the respiratory apparatus acts as a whole.

Lecture II.—The gases of the blood; Oxyhemoglobin and the conditions of its dissociation; The combinations of CO_2 in the blood and their dissociation; Effects of oxygenation of hemoglobin on the dissociation of CO_2; Exact physiological regulation of the blood-gases; Evidence that CO_2 acts physiologically as an acid; Investigations of

the reaction of blood; Extreme delicacy of the physiological regulation of the blood reaction; Regulation by the lungs, liver and kidneys; Effects of want of oxygen on the breathing; High balloon ascents, CO poisoning, and mountain sickness; Acclimatization to oxygen want:—the Anglo-American expedition to Pikes Peak in 1911; Acclimatization effects of oxygen want on the breathing; Acclimatization effects on the hemoglobin percentage and blood-volume; Acclimatization effects on active secretion inwards of oxygen by the lungs; Factors in acclimatization to want of oxygen.

Lecture III.—Further analysis of oxygen secretion by the lungs; Secretion of oxygen by the swim-bladder; Secretion in other glands; Analogy between secretion and cell-nutrition; The circulatory regulation of carriage of oxygen and CO_2; Regulation by vaso-motor nervous control; Evidence that this control depends upon the metabolism of the tissues; Evidence that the heart's action in pumping blood depends on the same conditions; Part played by contraction of the veins; The blood as a constant internal environment; Regulation of this internal environment by the kidneys; Regulation by other organs; Regulation after bleeding and transfusion; Regulation of the external environment; In reality the constancy of the internal or external environment is a balance between disturbing and restoring influences, each of which persists; The ordinary idea of "function" in an organ is misleading; "Causes" and "stimuli"—physiology as an endless maze of causes.

Lecture IV.—Examination of mechanistic interpretation of regulation of the environment; Difference between an organism and a machine; Life endures actively and develops; In life the whole is in the parts and the past is in the present; Organism, environment and life-history can not be separated; For biology life and not matter is the primary reality; The true aims and methods of biology; Biology an exact experimental science; Relation of physiological to physical and chemical investigation of organisms; The limitations of existing physical and chemical conceptions; Inadequacy of vitalism; Vitalism the inevitable accompaniment of attempted mechanistic interpretations of life; Individual life as a part of a wider life; The limitations of biological conceptions; Science and religion.

SCIENTIFIC NOTES AND NEWS

Josiah Royce, Alvord professor of the history of philosophy at Harvard University, distinguished for his contributions to philosophy, logic, ethics and psychology, died on September 14, in his sixtieth year.

The British government has appointed two committees to inquire, respectively, into the position of science and modern languages in the system of education of Great Britain. The members of the committee on science are: Sir J. J. Thomson (chairman), the Rt. Hon. F. D. Acland, Professor H. B. Baker, Mr. Graham Balfour, Sir William Beardmore, Bart., Sir G. H. Claughton, Bart., Mr. C. W. Crook, Miss E. R. Gwatkin, Sir Henry Hibbert, M.P., Mr. William Neagle, Mr. F. G. Ogilvie, C.B., Dr. Michael Sadler, C.B., Professor E. H. Starling, Mr. W. W. Vaughan, Mr. F. B. Stead, inspector of schools, secretary. This committee is instructed "to inquire into the position occupied by natural science in the educational system of Great Britain, especially in secondary schools and universities; and to advise what measures are needed to promote its study, regard being had to the requirements of a liberal education, to the advancement of pure science, and to the interests of the trades, industries and professions which particularly depend upon applied sciences."

Sir Charles H. Bedford has been appointed general secretary of the newly constituted Association of British Chemical Manufacturers. The business of the association is for the present being carried on at the offices of the Society of Chemical Industry.

Dr. I. J. Kligler, who has been in immediate charge of the bacterial collection of the department of public health of the American Museum of Natural History, has resigned to accept a position with the Rockefeller Institute. His place will be taken by Thomas G. Hull, Ph.D. (Yale, '16).

The Boston City Council has passed an ordinance that will give the city police court a medical department and psychologic laboratory. All offenders will pass through this department, the verdict of which as to their mental condition will be taken into consideration before sentence is pronounced. Dr. Victor V. Anderson is appointed as head.

PROFESSOR CHARLES SMITH PROSSER, head of the department of geology of the Ohio State University, has died at the age of fifty-six years. His body was found in the Olentangy River, near the university campus, on September 18. Dr. Prosser received his bachelor's, master's and doctor's degree at Cornell University and was instructor in paleontology there. Later he was paleontologist of the U. S. Geological Survey and professor at Washburn and Union Colleges, going to the Ohio State University in 1899. He was the author of important contributions to stratigraphical geology and paleontology.

WILLIAM ESSON, since 1897 Savillian professor of geometry at the University of Oxford, has died at the age of eighty-eight years.

S. B. MACLAREN, professor of mathematics in University College, Reading, died on August 14, as the result of wounds, while serving in the corps of engineers of the British army.

DR. C. C. CLOUGH, of the Scottish Geological Survey, died on August 27, aged sixty-three years.

WE learn from *Nature* that Captain A. R. Brown, formerly science master at Buckhaven High Grade School, and Second Lieutenant H. Watson, mathematical master at Ormskirk Grammar School, have both been killed in action.

DR. A. CHARPENTIER, professor of medical physics at Nancy, has died suddenly in his sixty-fifth year.

DR. WALTER ZURHELLEN, formerly an assistant director of the National Astronomical Observatory at Santiago, Chili, is, according to a wireless dispatch from Berlin, dead as a result of wounds received on the battlefield.

Two offices in the health department of the District of Columbia are created by Congress in the appropriation bill enacted September 1. A chief medical and sanitary inspector is to be appointed, who, under direction of the health officer, is to give his whole time to, and exercise direction and control of, the medical and sanitary conditions of the public schools, at a salary of $2,500 a year. He will assume charge of the thirteen medical inspectors and five graduate nurses now in the service. A chief food inspector, at $1,800 a year, is authorized to have general supervision and control of the food inspection service, comprising seventeen subordinate inspectors.

IN central Alaska south of the Yukon River there is a large area which prior to 1915 was practically unknown. In the summer of 1915 a small United States Geological Survey party in charge of H. M. Eakin made a rapid exploration from Tanana River at Cosna to the headwaters of Nowitna River and thence down the Nowitna to the Yukon. A preliminary statement of the important geologic and topographic observations made on that expedition has recently been published by the United States Geological Survey, Department of the Interior, as part of Bulletin 642, entitled "Exploration in the Cosna-Nowitna Region." Much time has been spent by a few prospectors in a search for placer gold on Nowitna River, but so far as is known the occurrence of commercial placers in that region has not been demonstrated. In much of the region prospecting is beset with considerable difficulty, owing to the great depth and breadth of the alluvial filling in the larger valleys. Although no lodes have yet been discovered the evidence available seems to suggest that the gold in the bedrock was probably introduced as a result of the igneous activities that produced the monzonites and granites, so that gold is most likely to be found near these intrusive masses. The map accompanying this report indicates the distribution of these intrusive rocks as well as of the other geologic formations.

DR. LUCY L. W. WILSON, excavating for the Philadelphia Commercial Museum, has closed her camp at Otowi, New Mexico. In this, her second season, she has (*a*) excavated 165 rooms and a kiva in the large pueblo; (*b*) located fourteen pueblos (two of them hundred room houses) on low ridges south of the large pueblo; (*c*) excavated fourteen rooms and a kiva in these smaller pueblos; (*d*) excavated and cleaned out the rooms in two three-story cliff dwellings in the mesa north and west of

the large pueblo; (e) explored the cave dwellings in the southern mesa and the caves in the so-called "tent villages." No certain evidence of prehistoric occupation was found in either case, in spite of reports to the contrary. Nine hundred and five artifacts were catalogued: 613 of stone, 159 of pottery, 88 of bone, 25 miscellaneous (fabric, rope, games, pendants, etc.) together with 21 burials and 53 evidences of food. Twenty-seven pieces of pottery were taken out whole, including five *tinajes*. The most important single find was that of an anthropomorphic figure of clay, originally colored red, with turquoise eyes and a turquoise in the chest. The work of excavation will be continued for at least another season.

ACCORDING to the London correspondent of the *Journal* of the American Medical Association the births registered in England in the fourth quarter of 1915 corresponds to a rate of 19.5 annually per thousand of the population. This rate is 4.6 per thousand below the mean birth rate in the ten preceding fourth quarters and 2.7 below the rate in the corresponding period of 1914; it is the lowest birth rate recorded in any quarter since the establishment of civil registration. The natural increase of population in England and Wales last quarter by excess of births over deaths was 46,368, against 87,995, 89,045 and 77,394 in the fourth quarters of 1912, 1913 and 1914, respectively. The deaths registered in the same quarter correspond to an annual rate of 14.6 per thousand persons living; this rate is 0.3 per thousand above the mean rate in the ten preceding fourth quarters, and 0.7 per thousand above the rate in the fourth quarter of 1914. During the year 1915 there were 814,527 births and 562,326 deaths registered in England and Wales. The natural increase of population, by excess of births over deaths, was, therefore, 252,201, the average annual increase in the preceding five years having been 378,360. The number of persons married during the year was 720,052. The marriage rate was 19.3 persons married per thousand of the population, which is 3.5 per thousand above the rate in 1914 and higher than the rate in any other year on record. One of the phenomena of the present time is the war wedding. The greater part of the young men of the country have joined the army and often marry before leaving for the front. The reason generally appears to be financial. If they join the ranks their wives are entitled to separation allowances, and if they are killed, to pensions. In the better classes, from which the officers usually come, the desire that their fiancées shall succeed to their property is another motive. Compared with the average in the ten years 1905–1914, the marriage rate in 1915 showed an increase of 3.9 per thousand. The birth rate was 21.8 per thousand of the population, which is 1.8 per thousand below the rate in 1914, and lower than the rate in any other year on record. Compared with the average in the ten years 1905–1914, the birth rate in 1915 showed a decrease of 3.6 per thousand. The death rate in 1915 was 15.1 per thousand, which was 1.2 per thousand above the rate in 1914. Compared with the rate in the ten years 1905–1914, the death rate in 1915 showed an increase of 0.7 per thousand.

WE learn from *Nature* that at the annual general meeting of the Chemical Society held at Burlington House, Dr. Alexander Scott presided, and a discussion took place with regard to the removal from the list of those honorary and foreign members who are alien enemies, and it was decided to refer the matter to the council for further consideration. It was with great pleasure the president announced that the following donations had been made to the research fund: (a) £1,000 from Dr. G. B. Longstaff, whose father, by his gift of a similar amount, was largely instrumental in founding the research fund forty years ago; (b) £1,000 from Mrs. and Miss Müller, in commemoration of the late Dr. Hugo Müller's long connection with the society; (c) £500 from Dr. Alexander Scott, to mark his appreciation of the valuable work done by the research fund, and in commemoration of the seventy-fifth anniversary of the society. Professor G. G. Henderson and Professor A. Lapworth were elected new vice-presidents, and Mr. A. Chaston Chapman, Mr. C. A. Hill, Dr. R. H. Pick-

ard, and Dr. F. L. Pyman were elected as new ordinary members of council.

The Chemists' Club of New York announces the establishment of another scholarship fund, the income from which, approximately $400 per year, is to be devoted to assisting financially deserving young men to obtain education in the field of industrial chemistry or chemical engineering. This scholarship has been endowed by Mr. Wm. F. Hoffmann. Its benefits will be open to properly qualified applicants without restriction as to residence, and may be effective at any institution in the United States which may be designated or approved by the Chemists' Club. In accordance with the deed of trust applicants must, as a minimum qualification, have completed a satisfactory high-school training involving substantial work in elementary chemistry, physics and mathematics and present a certificate showing that they have passed the entrance examination requirements of the College Entrance Examination Board or its equivalent. Preference will be given to young men who have supplemented these minimum qualifications with additional academic work, especially in subjects which will form a suitable foundation for the more advanced study of applied chemistry and chemical engineering. All inquiries should be addressed to the Hoffmann Scholarship Committee of the Chemists' Club, 50 East 41st Street, New York City. Applications for the next academic year should be in the hands of the committee on or before June 1, 1917. The scholarship will be awarded and candidates selected and notified on or before July 1.

In his anniversary address to the Society of Antiquaries, the president, Sir Arthur Evans, made the following observations:

I am well aware that the question of the expulsion, or at least suspension, of German honorary members of this and other learned societies in this country is in the air. There seems, at the same time, to be a general consensus of opinion that if any action in this matter be considered desirable it should be taken in common. To this end your council have empowered me to submit proposals on their behalf. But I will not attempt to conceal from the society my own feelings on this grave matter. . . . The existence among German honorary fellows of savants belonging to that noble class of which the late Dr. Helbig stood forth as a conspicuous example—to whom the brotherhood of science was a bond at least as great as that of nationality and language—should give us pause before we carry out any too sweeping measures. In spite of the "Gospel of Hate," let it be said to their credit, the learned societies and academies of Germany, with inconsiderable exceptions, have refrained from striking their English members from their rolls. In spite of official pressure, the Academy of Berlin has twice refused to take this action. I myself am not ashamed of confessing that I have received, in the period of the war itself, cordial and even unsolicited assistance from a German archeologist, occupying a high official position. . . . In these times of intolerable provocation we, and members of kindred societies, who stand on the neutral ground of science have a high duty to perform. That there should be a serious and prolonged estrangement of the peoples of the British commonwealth from those of the German empire has become inevitable. But this does not affect the immutable condition of all branches of research, which is their essential interdependence. We have not ceased to share a common task with those who to-day are our enemies. We can not shirk the fact that to-morrow we shall be once more laborers together in the same historic field. It is incumbent on us to do nothing which should shut the door to mutual intercourse in subjects like our own, which lie apart from the domain of human passions, in the silent avenues of the past.

We learn from the *British Medical Journal* that the museum of the French army medical service installed at the Val-de-Grâce military hospital under the direction of Professor Jacob, was recently formally opened by M. Justin Godard, under secretary of state of the sanitary service. On the ground floor are a library, an archives room, and others for specimens, mouldings and apparatus. The first floor is given up to a collection of the instruments of destruction—bullets, shells (incendiary, shrapnel, asphyxiating and explosive gases), aerial torpedoes, Zeppelin and aeroplane bombs—used by the Germans; alongside these are specimens of protective apparatus (helmets and masks). Then comes a miniature exposition of sanitary cantonments, special

beds, and other hygienic inventions for use at the front. A laboratory of antityphoid vaccination displays the apparatus, the preparations used, and the graphic records. Painted sculptures by M. Jean Larrivé illustrate the working of the sanitary service. A series of reliefs shows first aid in the trenches, the transport of a badly wounded man, the arrival at the first line dressing station, and the interior of the station. A room is set apart for surgical instruments and sterilizing apparatus, with models showing the disinfection of wounds by the Dakin method.

A VALUABLE collection of foreign and domestic woods in panel form is being installed on the second and third floors of the rotunda in the new $250,000 Forestry Building of the State College of Forestry at Syracuse. For the past two years search has been made throughout the country for available commercial varieties of wood native to this country, as well as the important commercial woods from South America, Mexico, the West Indies, Africa and the East Indies. Among the rare foreign woods that will be displayed as panels around the rotunda in the College of Forestry building are African gaboon, East India koa, marblewood, East India rosewood, satinwood, camphor wood, teak, Circassian walnut and eight different kinds of mahogany. Among the western woods of this country displayed are Douglas fir, California redwood, sugar pine, western yellow pine, Sitka spruce, Port Oxford cedar, incense cedar and several varieties of eucalyptus. The southern forests are represented by cypress, southern hard pine, North Carolina pine, red and black gum, cucumber and persimmon. A great variety of native hard and soft woods found in New York are the nucleus around which these rarer woods are gathered. The collection of panels of native and foreign woods built into the rotunda of the College of Forestry building at Syracuse are being finished carefully to bring out the natural grain to best effect and at the same time to detract as little as possible from the native color and natural wood fibers. Each panel is to be labeled with the common and scientific name so that both the student body of the college and the many visitors who come to the building may study a permanent exhibit of unusual interest and value. Lumber manufacturers' associations and lumbermen throughout the country have been cooperating very cordially with the New York State College of Forestry in supplying these panels.

A MACHINE for testing the strength of boxes has been devised by engineers of the Forest Service and is in use at the Forest Products Laboratory at Madison, Wisconsin. The machine is the result of experiments made to determine a fair test for all types of boxes. A series of tests in cooperation with the American Society for Testing Materials and the National Association of Box Manufacturers has been carried on during the past year to determine the strength of boxes of various woods and of different construction. Over four and a half billion feet of lumber is used for box making every year, and on this account the tests are considered important. Moreover, big losses are caused by the breakage of boxes in transit, and all parties concerned are said to be anxious to determine the best kind of box. The machine consists of a hexagonal drum with 3½-foot sides, which is lined with thin steel sheets. Pieces of scantling bolted to the bottom form what are known as "hazards." In making the tests boxes filled with cans containing water are placed in the drum, which is then rotated. For convenience in observing the results of the tests, the sides and ends of the box are numbered with large figures, and in addition other numbers are placed at specified points on each side. The "hazards" cause the boxes to be carried part way round and then dropped back to the lower level of the drum. Each fall of this sort is a pretty fair imitation of the probable treatment it would receive in shipment. The boxes are watched carefully, and notes are taken on the manner in which they give way and the number of falls required to break them in pieces. In this way it is possible to determine what kinds of woods are best suited for boxes. The tests showed a decided need for a standard classification of box woods, and three

groups have been made, based on the data that were obtained.

LEADING metal-producing companies from all sections of the country will be represented by members of their staff at the meeting of the American Institute of Mining Engineers, which convenes in Arizona on September 18. The country's record production of metal during the past year has greatly stimulated the interest in those general mining topics which will be discussed at the institute's sessions. More than twenty corporations have already expressed a desire to be represented by institute members who may participate in the technical gathering. Some of these are Anaconda Copper Mining Co., the largest copper producing company in the country; American Smelting and Refining Co., the largest lead-producing company; Ray Consolidated Copper Co., Treadwell and Alaska Juneau mines, Miami Copper Co., and the New Jersey Zinc Co. Among the engineers who will be present are L. D. Ricketts, Benjamin B. Thayer, William L. Saunders, Sidney J. Jennings, George D. Barron and Philip N. Moore. A special train from New York will be the traveling headquarters, the train moving from point to point in Arizona each day during the week of the convention. Some seventy papers have been prepared for discussion at the meeting. These papers bear largely upon new methods of production and the mining outlook in various parts of the world.

UNIVERSITY AND EDUCATIONAL NEWS

UNDER the will of William Watson Lawrence, of Pittsburgh, Princeton University will ultimately receive the residue of his estate, estimated at more than $750,000.

PROFESSOR CARL T. DOWELL, instructor of chemistry at the University of Texas, Austin, has been elected associate professor of chemistry at Tulane University.

THE following appointments and changes are announced from the University of Illinois: Professor Richard C. Tolman, recently at the University of California, has been appointed professor of physical chemistry to succeed Professor E. W. Washburn, who has been appointed head of the department of ceramics. Dr. Roger C. Adams has been appointed assistant professor of organic chemistry to succeed Dr. C. G. Derick, who is organizing a research laboratory for the Schoellkopf Aniline and Chemical Works in Buffalo. Dr. Horace G. Deming, recently returned from the Philippines, has been appointed associate in chemistry to assist in the instruction in general chemistry and qualitative analysis. Professor C. W. Balke, formerly at the head of the division of general chemistry and qualitative analysis is organizing a research laboratory for the Pfanstiehl Company in North Chicago which is engaged in the application of rare metals to industrial uses.

DISCUSSION AND CORRESPONDENCE

VITALISM

I HAVE read with much interest the addresses that have appeared in SCIENCE, forming part of a symposium on "The Basis of Individuality in Organisms." But I have not noted that two well-known facts, that seem to me of major importance to the discussion, have been jointly focused on the problem. May I mention them, and briefly suggest their bearing?

1. I assume all would agree that non-perceptual realities—Spencer's Unknowable, Kant's Ding-an-sich, Locke's Something, I know not what, that supports sensations—exist, and are the kernel of *all* matter, dead and living. These realities—whose natures remain so dim to our inquiries—it is that *behave* in the ways laboriously and skilfully discovered, described and formulated by natural science. Their existence and basal activity might, further, be thought to validate vitalism. For the active beings (*i. e.*, themselves) of which conscious organisms are aware are the very realities that behave after the conscious fashion, and their natures might reasonably be thought to throw light on their behavior, as has, in fact, been

the case. But such an inference goes too fast.

2. The behavior of certain groups, even when viewed phenomenally, in abstraction from their realities, as natural science views them, is different from the behavior of the aggregate of their components ungrouped; and the behavior of the components grouped is different from their behavior ungrouped; different as regards the scientific laws they observe. The proper number of electrons act differently, individually and collectively, before and after being grouped into an atom of helium. And so with the atoms that form molecules; the molecules that form cells; the cells that form organisms; the organisms that form crowds or societies.

Here, as I see it, emerges the question of the acceptance or rejection of vitalism, *as a factor in natural scientific explanation*—1, above, shows we must accept it as a fact. If it can be successfully maintained that a *full* knowledge of the *perceptual behavior* of electrons, atoms and molecules, before they are grouped and regrouped into cells and organisms, will enable us to predict their behavior, and the behavior of the cells and organisms they form, after the grouping and regrouping, then vitalism is not needed for natural scientific explanation. If not, non-perceptual realities being existent, potent and observable, in the case of conscious beings, they, and therefore vitalism, must be availed of to eke out our otherwise incomplete explanations. Of course, our present knowledge does not permit such predictions, and therefore ordinary intercourse, the social sciences, and psychology, are *per force* vitalistic in explanation, for the present at least. But the antivitalists maintain that full prediction will come some day, and that meantime we should not be scientifically—I should say natural scientifically; psychology at least is a science—satisfied till it does; while the vitalists believe our knowledge of outer perceptual happenings never will permit full prediction, though it probably will approximate more and more closely to doing so.

Whichever side is right, two facts should not be forgotten. (1) Though living cells and organisms act according to the chemical and physical laws observed by electrons, atoms and molecules in their simpler groupings, they also, *and in addition*, behave after the higher vital fashion; *i. e.*, intelligently and any explanation offered by natural science that pretends to explain intelligence *away* is incorrect or incomplete, because false to the facts it is bound to respect. (2) The *real agents*, whose activities the sciences of nature, among others, are called upon to describe and explain, are, in the case of us men, the Egos of which we are severally confusedly conscious.

In sum, then, natural scientists, as such, must deny vitalism, in order to achieve the maximum of explanation in quantitative and phenomenalistic terms; but practical and philosophic men, viewing their problem entire, and engaged in the larger game of living, must recognize and reckon with the effective reality of the human (and animal) Ego.

I ask indulgence for the dogmatic tone, assumed in the interest of terseness; it conceals not a few modesties.

S. E. Mezes

The College of the City of New York

THE ANIMAL DIET OF EARLY MAN

It may be the merest speculation to say what early man did or did not eat, but, there appears to be rather strong zoological evidence that man and his ancestors have long indulged in three forms of animal food which to-day are commonly found in markets. The perfect adaptation to their definitive and intermediate hosts and the rather high degree of differentiation of the three large tapeworm parasites of man must impress itself upon every one who gives the matter consideration and yet it is a point which I have not seen mentioned in the books on animal parasites with which I am familiar.

The tapeworms referred to are the beef tapeworm, *Tænia saginata;* the pork tapeworm, *Tænia solium,* and the fish tapeworm, *Dibothriocephalus latus.* The definitive host of the two tænias is man, and I believe man alone. The intermediate host of *Tænia saginata* is *Bos taurus.* The common intermediate host of *Tænia solium* is the pig, *Sus scrofa,* less

commonly man himself, very rarely other animals. Both these tapeworms are rather highly specialized and do not appear to be readily adaptable to other hosts. The conclusion seems clear that man has been eating cattle and pigs or their immediate ancestors, and perhaps himself, for as many ages as needed for these tapeworms to attain their present degree of differentiation. We have no evidence that species of any kind are rapidly produced, and the parasites have probably had as slow an evolution as man himself. The fish tapeworm has other definitive hosts than man, notably the dog and the evidence is not conclusive that early man was piscivorous. The ease, however, with which man becomes infested with this parasite might indicate that he had eaten uncooked fish for a long period.

The adaptability of trichina, *Trichinella spiralis*, for man and pigs is rather significant in this connection, but trichina seems to thrive so easily in almost any mammalian host that not much weight can be attached to that parasite as indicating a pork diet for early man.

The idea of the concomitant evolution of these human parasites, of man, and of the animals serving as food for him and intermediate hosts for the parasites has interested me for some time. It has recently been brought to the foreground by Gregory's "Studies on the Evolution of the Primates"[1] in which he so graphically describes (pp. 342–344) the evolution of human food habits. On different grounds from parasitology Gregory concludes that the wild boar was "one of the first medium-sized animals that the nascent Hominidæ would be successful in killing." The only other animal mentioned by him as probable food of early man is the horse. Our knowledge of the beef tapeworm seems to indicate that *Bos taurus* or its progenitors were eaten as well as early horses. There is nothing to show that horses were not eaten, unless the rather widespread abhorence of eating horse-flesh at the present time can be construed that man never adapted himself to that diet as he did to beef.

[1] *Bull. Amer. Mus. Nat. Hist.*, Vol. 35, pp. 239–355, June 16, 1916.

It is not beyond possibility that the acquirement of a meat diet by the vegetarian pre-men may by improvement of nutrition, by shortening of digestive processes, and by stimulating properties of proteins and their split-products have played an important part in man's evolution over his vegetarian competitors.

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SCIENTIFIC BOOKS

Napier Tercentenary Memorial Volume. Edited by Cargill Gilston Knott. Published for the Royal Society of Edinburgh by Longmans, Green and Company. London, 1915. Pp. xii + 422. Price, $7.00.

The International Congress which met at Edinburgh from Friday, July 24, to Monday, July 27, 1914, to commemorate the tercentenary of the publication of John Napier's "Mirifici Logarithmorum Canonis Descriptio" was the last great international assembly of scientists before the Great War. Appreciations of English scientists and congratulatory addresses by German scientists and German universities, in honor of an Englishman, will probably not soon be seen again.

The variety of interests touched by such an invention as logarithms, in its developments, is so well illustrated by the papers of this memorial volume that it seems desirable to present the list.

"The Invention of Logarithms," by Lord Moulton, president of the congress.

"John Napier of Merchiston," by Professor P. Hume Brown, University of Edinburgh.

"Merchiston Castle," by George Smith, master of Dulwich College, formerly headmaster of Merchiston Castle School.

"Logarithms and Computation," by J. W. L. Glaisher, Trinity College, Cambridge.

"The Law of Exponents in the Works of the Sixteenth Century," by Professor David Eugene Smith, Columbia University.

"Algebra in Napier's Day and Alleged Prior Inventions of Logarithms," by Professor Florian Cajori, Colorado College.

"Napier's Logarithms and the Change to Brigg's Logarithms," by Professor George A. Gibson, University of Glasgow.

"Introduction of Logarithms into Turkey," by Lieutenant Salih Mourad, of the Turkish navy.

"A Short Account of the Treatise, 'De Arte Logistica,'" by Professor J. E. A. Steggall, University of St. Andrews, Dundee.

"The First Naperian Logarithm Calculated before Napier," by Professor Giovanni Vacca, University of Rome.

"The Theory of Naperian Logarithms Explained by Pietro Mengoli (1659)," by Professor Vacca.

"Napier's Rules and Trigonometrically Equivalent Polygons," by Professor D. M. Y. Somerville, Wellington University, New Zealand.

"Bibliography of Books Exhibited at the Napier Tercentenary Celebration, July, 1914," by Professor R. A. Sampson, University of Edinburgh.

"Fundamental Trigonometrical and Logarithmic Tables," by Professor H. Andoyer, University of Paris.

"Edward Sang and his Logarithmic Calculations," by Professor C. G. Knott, University of Edinburgh.

"Formulæ and Scheme of Calculation for the Development of a Function of two Variables in Spherical Harmonics," by Professor J. Bauschinger, University of Strassburg.

"Numerical Tables and Nomograms," by Professor M. d'Ocagne, l'Ecole Polytechnique, Paris.

"On the Origin of Machines of Direct Multiplication," by Professor d'Ocagne.

"New Table of Natural Sines," by Mrs. E. Gifford.

"The Arrangement of Mathematical Tables," by Dr. J. R. Milne, University of Edinburgh.

"Note on Critical Tables," by Mr. T. C. Hudson, of the Nautical Almanac staff.

"On a Possible Economy of Entries in Tables of Logarithmic and Other Functions," by Professor Steggall.

"The Graphical Treatment of some Crystallographic Problems," by Dr. A. Hutchinson, Pembroke College, Cambridge.

"A Method of Computing Logarithms by Simple Addition," by William Schooling.

"How to Reduce to a Minimum the Mean Error of Tables," by A. K. Erlang, Copenhagen University.

"Extension of Accuracy of Mathematical Tables by Improvement of Differences," by Dr. W. F. Sheppard.

"Unpublished Tables Relating to the Probability-Integral," by Dr. Sheppard.

"A Method of Finding Without the Use of Tables the Number Corresponding to a given Natural Logarithm," by Dr. Artemas Martin, of the U. S. Coast and Geodetic Survey.

"Approximate Determinations of the Functions of an Angle, and the Converse," by Mr. H. S. Gay, of Shamokin, Pa.

"Life Probabilities; on a Logarithmic Criterion of Dr. Goldziher and on its Extension," by M. Albert Quiquet, general secretary of the Institute of French Actuaries.

In addition to the above scientific papers the volume includes a record of the proceedings of the congress, with a list of the members, and subject and name indices.

Of particular interest is the announcement of new tables, prepared or under preparation, made at this congress. Mrs. Gifford has constructed and published a table to every second of arc of natural sines to eight places of decimals. Such tables will be increasingly in demand since the larger calculating machines are supplanting in many instances logarithms. No little surprise is occasioned by the fact that a mathematician and astronomer of the ability of Professor Andoyer should have devoted several years to the laborious task of computation of tables. The partial fruit of this effort is the publication of the logarithms of the trigonometrical function for every ten seconds of arc to fourteen places of decimals; a large quarto volume of 600 pages, appearing at Paris in 1911. Following this there is in course of publication, evidently delayed by the war, a similar table of the natural functions, to form a quarto volume of about 1,000 pages. Professor Andoyer contemplates further a 14-place table of logarithms of numbers between 100,000 and 200,000. Another set of tables which may be published, and which would render unnecessary the last work mentioned, is the tables of logarithms to fifteen places of the natural numbers from 100,000 to 370,000 by Dr. Edward Sang. The computer resided in Edinburgh where he died in 1890. His tables are accurate to fourteen places, and the manuscript was prepared with such care that it would lend itself admirably to reproduction by photographic processes; to include his tables

of logarithms to 28 figures of the numbers from 1 to 10,000 and to 15 figures of the numbers from 100,000 to 200,000 will require a volume of 1,100 pages.

In the paper by Mr. H. S. Gay the final formulæ are unfortunately incorrectly printed (p. 367). Corrected these should read, as follows:

$$\alpha = \frac{\sin \alpha}{.01147 + .006 \cos \alpha}, \quad \alpha \text{ less than } 45°.$$

$$90 - \alpha = \frac{\cos \alpha}{.01147 + .006 \sin \alpha}, \quad \alpha \text{ greater than } 45°.$$

It is interesting to note that the author, a practising engineer, arrived at his approximate determinations of the sine and cosine by a consideration of first and second differences; similar considerations appear in the earliest tables of sines, in the Hindu Surya Siddhanta and in the work of Aryabhatta, a Hindu astronomer of the sixth century A.D.

The historical notes in connection with the conception and development of logarithms are of real interest. Professor David Eugene Smith discusses admirably the treatment in early works on algebra and arithmetic of the law of exponents. Any careful study of the evidence presented by Dr. Smith will show that the way was being well prepared for the invention of logarithms, so that no surprise need be occasioned by the fact that other claimants to the honor of the discovery have their *patriotic* supporters. Professor Florian Cajori meets in a definite and decisive manner the arguments which have been advanced in favor of the priority in the field of the Swiss writer, Joost Bürgi, sometimes claimed as a German. Cajori says:

> They compare Bürgi's supposed date of invention with Napier's date of publication, and therefrom do not conclude, as they legitimately could, that Bürgi was an independent inventor, but they conclude, as they can not legitimately do, that Bürgi's invention was prior to Napier's, or that Bürgi very probably lost priority simply because of failure to publish his logarithms as soon as invented by him.

This memorial volume is marred by the mistaken efforts to ascribe to Napier the discovery of imaginaries, and the introduction of the decimal point. Numerous writers, notably Cardan and Bombelli, had a much more profound grasp of imaginaries than is anywhere exhibited by Napier. So far as the decimal point is concerned Pitiscus in his "Trigonometry" of 1612 preceded by four years Wright, or Napier, in the use of the comma which appears in Wright's 1616 translation of the "Descriptio" and in Napier's "Rabdologiæ" of 1617; that Napier was familiar with the work of Pitiscus is proved by the fact that in both the "Descriptio" and the "Rabdologiæ" Pitiscus is cited. The spread of the decimal system was greatly facilitated by Napier's adoption, but it is not warranted to ascribe to him any "share in the improvement of decimal arithmetic."

The historical notes (pp. 159–161) to the article on the "De Arte Logistica" are replete with errors. In the dates on the progress of arithmetical and algebraical printing Lucas de Burgo comes first, followed by Cardan with "the next known book." Arithmetics printed before Cadan's work of 1539 occupy 192 pages of Smith's "Rara Arithmetica" while in algebra the well-known works of Grammateus and Ghaligai precede Cardan. Stifel or Stifelius (not Stifellius) did not introduce the $+$, $-$ and $\surd$ signs. Even the English algebra by Robert Recorde is cited as of date 1552, instead of 1557. The concluding remarks to the effect that in Napier's day and for some time afterwards arithmetic and algebra were no part of the mathematical curriculum is absurd. The solution of the cubic and the biquadratic was effected nearly one hundred years before the time of Napier's great publication; Vieta's introduction of literal coefficients preceded by more than twenty years; the serious study of algebra and arithmetic made in the time of Napier prepared the way for the invention of the analytic geometry and the calculus, introducing the era of modern mathematics.

To his contemporaries Napier's most celebrated work was "A Plaine Discovery of the whole Revelation of St. John," published in

1593 and followed by three Dutch editions between 1600 and 1607, by nine French editions between 1602 and 1607, by four German before 1627, and by several other English editions. In this, following the conclusion that the Pope is Antichrist, the end of the world is set to fall between 1688 and 1700. This type of arithmetical mysticism in the study of "Revelations" appealed to many other mathematicians of the sixteenth and seventeenth centuries, some of whom were not so wise as to set the end of the world sufficiently distant to be safe.

From the time of the earliest known trigonometrical tables of Hipparchus and Ptolemy, probably based upon Babylonian documents, down through the ages there has been a continued interest in such mathematical tables. The Babylonians, the Greeks, the Hindus, the Arabs, the Europeans of the Middle Ages, and many of the nations of the present day have contributed energetic workers to this field. No one can deny to Napier the just claim to having made the greatest contribution for the final construction of tables sufficient for computation purposes of the most diverse types.

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A NEW TRIANGULATION SIGNAL LAMP

State, county and city surveyors must look to the national government for the exact geographical positions upon which to base their respective surveys. The duty to establish and furnish these positions devolves upon the United States Coast and Geodetic Survey.

The geodesist determines astronomically with the greatest possible exactness the longitude and latitude of selected principal points, suitably distributed over the whole country. The geographical positions of the many places between these principal points required are ascertained most accurately and economically by means of what is called triangulation. A rough, preliminary or reconnaisance survey reveals those points which are intervisable and most desirable as to distance and other characteristics, to form the corners of connected triangles. From the measured length of one side of a suitably selected one of these triangles and the angles of all the interconnected ones, the exact latitude and longitude of each point is computed.

Though the general principle employed in the measurement of these angles is the same as that applied in the survey of a railroad, a farm, etc., the great distance between the points, varying between ten and a hundred miles or over, requires not only the use of specially large and refined instruments, but also a special means of making the point visible to the observer. This latter is now done, in day time, by reflecting sunlight to the observer from a mirror placed accurately over the point, and at night by means of a specially constructed acetylene lamp.

It is apparent that distances of the magnitude mentioned can be penetrated by either means only under favorable weather conditions, and that many days during a season are lost even when the atmosphere is only slightly clouded by smoke, fog, etc. As the expense to maintain the party, which amounts to from \$50 to \$60 per day, goes on whether observations are made or not, it was thought that advances in illuminating devices made since the lamp now used was adopted might be utilized to increase considerably the intensity of the light directed to the observer, and thereby increase the number of observing nights.

Experiments made with calcium light produced by the oxy-acetylene flame showed this form of illumination to be impracticable by reason of cost and bulkiness of the apparatus necessary.

The storage cell was studied with the view of using electricity as a source of light. Its cost and weight and the difficulties connected with its maintenance were found to be too great. The electric generators with the necessary prime motor were carefully studied, tried experimentally and found to be too heavy for transporting to difficult stations, and doubtful as to continued and unfailing service.

The result of a series of tests of dry cells, which are readily divisible into loads suitable for climbing difficult ascents, however, warranted the design and construction of a new

type of lamp, the use of which, undoubtedly, will increase the present number of observing nights per month by at least twenty-five per cent.

The main part, an ordinary automobile head light, is suitably mounted for directing in the horizontal and vertical; the lamp is provided with an ammeter, a small rheostat and a switch. The whole, packed in a strong case, weighs twenty-three and one half pounds.

In order to obtain most nearly the maximum intensity of the light, it was necessary that the lamp bulb be provided with a filament concentrated to a degree not found in those on the market. One of the lamp manufacturers was induced to make the necessary designs and experimental tests, and submitted a number for trial.

At the present time all the lights of the stations surrounding the observer's station are kept burning continuously from sunset to the closing of the observations for the night. The use of the dry cell was found practicable and not too costly on the assumption that the proposed lamp was to be kept burning throughout the night. The trial of the newly designed lamp by comparison with the present acetylene lamp, however, proved the former so much superior, that it was decided to have the lights shown only on signal, flashed with one of the new lamps by the observer, for the few minutes each time it is observed upon. This reduces very materially the consumption of current and battery cost.

The lamp, after being provided with two additional bulbs, one for medium and one for short distances, was tested by the Bureau of Standards, with the following results:

Apparent candle power, at a distance of 100 ft. Lamp with specially concentrated filament, gas filled, 6 volts, 2.5 amp.	250,000
Automobile lamp, 6 volts, 1.8 amp.	50,000
Flash light lamp, 2.7 volts, .34 amp.	6,000

The candle power of the acetylene lamp now used in the triangulation carried on by the survey, measured under the same conditions, is 1,500.

E. G. FISCHER

U. S. COAST AND GEODETIC SURVEY

SPECIAL ARTICLES

LINKED MENDELIAN CHARACTERS IN A NEW SPECIES OF DROSOPHILA

IN my cultures of a new species of *Drosophila*, tentatively called "species *B*,"[1] several mutants have recently appeared. They have not all been tested fully with respect to their linkage relations, but enough has been learned to suggest some interesting possibilities when considered in connection with the results of Morgan and others on *Drosophila ampelophila*. Three linkage groups have already been obtained in my material, and five characters remain to be studied. Of the linkage groups one is sex-linked and contains four characters, the others are non-sex-linked and are composed, respectively, of one and two characters.

So far as the evidence goes, it indicates a mode of inheritance in this fly entirely comparable with that in *D. ampelophila*, although I have as yet been unable to determine whether or not there is "crossing over" in the male, because the only linked factors thoroughly studied (aside from the sex-linked group) are completely linked and give no crossing over in either sex.

The most interesting feature of the results, as they stand at present, is the apparent correspondence between certain mutant characters in this species and in *D. ampelophila*. Four of the characters I have obtained show this correspondence. One of them ("confluent") has already been recorded.[1] It is a dominant, non-sex-linked character, and has a lethal effect when flies are homozygous for it. Its counterpart in *ampelophila* is an almost exact duplicate in appearance, and apparently has the same peculiarities in genetic behavior. There seems to be little doubt that these characters are actually alike in the two species. The other three are "black," "yellow" and "forked." Black has only been studied enough to tell that it is not sex-linked; and since there are two or three factors in *ampelophila* that give a melanistic effect, there is some doubt as to which, if any, is really comparable to the one I have found. But with respect to yellow and forked the case is different, for they not only correspond exactly in appearance, but

[1] Metz and Metz, "Mutations in Two Species of *Drosophila*," *Amer. Nat.*, 1915.

they belong to the same linkage group, in both species. Since this happens to be the sex-linked group it means in reality that three corresponding factors—the sex factor, the yellow factor and the forked factor—are linked in both species. Whether the same degree of linkage obtains in each has not been determined.

It is, of course, too early to generalize from this one case, but certainly the evidence strongly suggests that there is a genetic continuity of factorial associations in these flies. And if the factors are located in the chromosomes it is equally suggestive of a genetic continuity of the chromosomes.

So far as I know this is the first clear case of the kind on record, and since the work promises further evidence on the same point a word may be said regarding the chromosomes of the species concerned. As is well known *Drosophila ampelophila* has four pairs of chromosomes—two of large euchromosomes, one of shorter sex-chromosomes and one of very small "*m*-chromosomes." In contrast to this the species I am breeding has six chromosome pairs, of which only two resemble those in *ampelophila*. The latter are the sex-chromosomes and the "*m*-chromosomes." The other four pairs replace the two euchromosome pairs of *ampelophila* and are individually about half their size.[2]

Upon the chromosome hypothesis characters in this new species should fall into six linkage groups instead of four. And what is of much greater interest, if present indications are reliable, it may eventually be possible to compare these groups (and hence the chromosomes?) individually with those in *ampelophila* by means of corresponding characters. The first step in this comparison may be represented by the sex-linked characters yellow and forked mentioned above.

A more detailed report of these results will be presented as soon as certain experiments now under way are completed.

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[2] See Metz, C. W., "Chromosome Studies in the *Diptera*," I., *Jour. Exp. Zool.*, 1914, p. 50.

BACTERIAL BLIGHTS OF BARLEY AND CERTAIN OTHER CEREALS

AT the Columbus meeting of the American Phytopathological Society the writers reported on a bacterial disease of barley. This was described as a widely occurring disease attacking leaves, leaf sheaths and glumes, early characterized by water-soaked lesions with bacterial exudate, and later by the persistent transparency following the death of the parts invaded. The abstract of this paper appeared in *Phytopathology* (Vol. 6, p. 98). Laboratory and field studies have now been completed which confirm all of the preliminary statements and furnish the data for the publication of the causal organism as a new species. It is a monotrichous rod with a single polar flagellum, hence referable to Migula's genus *Pseudomonas*. Field and laboratory studies have combined to show that it is seed borne, and that in this way it is readily disseminated. This fact accounts for its very general distribution, it having already been collected from eight states. Not only has the development of the disease been traced in the field where infected seed was used, but, in addition, the organism has been secured in pure culture from seed collected two years previously, and successful inoculations with this have proved its continued virulence.

Diseases very similar to the one on barley have been found and studied on wheat, spelt and rye. These have all been proved to be of bacterial origin. From each of these hosts the causal organism has been isolated, and its pathogenicity fully determined. The organisms from these three sources are apparently all one species and they are very similar to the barley blight organism.

This similarity holds for the appearance and development of the disease lesions, and for the morphological and cultural characters of the organisms. All like the barley organism are monotrichous and yellow in culture. The chief difference noted is in the behavior in cross inoculations. The barley blight organism when inoculated on wheat, rye, spelt, oats and barley, infects barley only. The wheat,

rye and spelt organisms all behave alike as to pathogenicity when inoculated on wheat, rye, spelt, barley and oats in that they each infect all these grains except oats. A blade blight of oats quite different in type from the blights of the other grains noted above has also been found in Wisconsin and its bacterial cause determined. This disease apparently corresponds in appearance with the bacterial blade blight of oats described by Manns.[1] From it a monotrichous white organism has been isolated which in pure culture infects oats readily but apparently is not pathogenic on the other cereals listed above.

The detailed account of the studies upon barley blight together with the technical description of that organism as a new species has already been sent to press. The results of the comparative studies on these other bacterial grain blights will be given in a subsequent publication.

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ANOTHER USE OF THE DOUBLE-PLATE METHOD[1]

IN a study of the antagonism exhibited by certain bacteria for *B. typhosus*, one of us (W. D. F.) used and described a method called by us the "double-plate method."[2] This method enabled us to see and photograph the effect which certain bacteria had in limiting or preventing the growth of *B. typhosus*. The method consisted of dividing a petri dish in halves by means of a small rod or tube and flooding one half of this double-plate with sterile agar and the other with agar containing the antibiont. Over the surfaces of both halves the other antibiont was streaked. The resulting growth of the streaks readily showed the effect of the antagonism.

Some eight years later, Churchman[3] describes an identical procedure for demonstrating the selective action of gentian violet. He makes no mention of our method but substitutes a metal strip for the glass rod and the name "divided plate" for double-plate. He was evidently not aware of our previous description.

Recently we have used this method for deter-

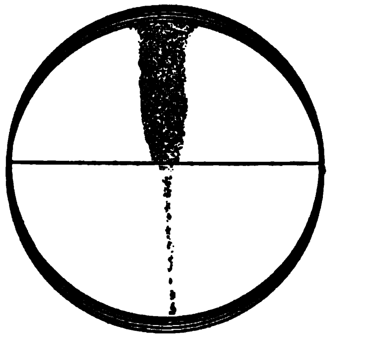

FIG. 1. *Aspergillus* growing on potato agar. The lower half contains oil of nutmeg (1: 200) which inhibits growth of mold.

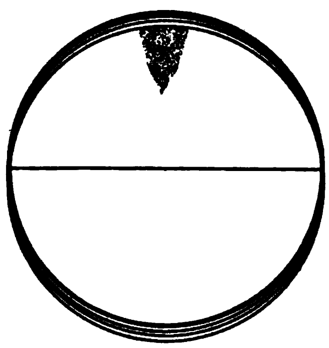

FIG. 2. *Penicillium* on potato agar. Marked inhibition due to eugenol (1: 1,000) in lower half of dish.

1 Manns, T. F., "The Blade Blight of Oats; a Bacterial Disease," *Ohio Agr. Exp. Sta. Bull.*, 210, pp. 91–167, 1909.

1 Read at the meeting of the Society of American Bacteriologists, Urbana, Ill., December 28–30, 1915. Publication authorized by the Director of the Wisconsin Experiment Station.

2 Frost, W. D., "The Antagonism Exhibited by Certain Saprophytic Bacteria Against the *Bacillus typhosus* Gaffky," *Jour. Inf. Dis.*, November 5, 1904, pp. 599–641.

3 Churchman, "The Selective Bactericidal Action of Gentian Violet," *Jour. Exp. Med.*, Vol. 16, 1912, pp. 221–247.

mining the effect which spices have on microorganisms. Here the spice or condiment is mixed with the agar and poured on one side of the plate, plain agar on the other and streaks of the organism in use made across both. A modification in the method of preparation has been adopted which obviates the necessity of using rods or metal strips. This consists of cutting semi-discs of muslin (cheesecloth) which are sterilized in the petri dishes. Plain agar is poured over the entire dish and then when the agar is hard the piece of cloth with adherent agar is taken out from each petri dish with sterile forceps and into its place is poured the agar containing the condiment to be tested. The cloth semi-discs are more easily prepared than the rods and the union between the agar in the two halves of the plate is more direct. This, we take it, is an advantage since it readily permits of diffusion. The agar clinging to the cloths need not be wasted but may be saved by throwing the cloths into a funnel and allowing the agar, when liquefied, to drain off into a flask. Instead of plain nutrient agar, potato or wort agar, gelatine or other liquefiable solid media favorable to the growth of organisms to be studied, may be used.

The accompanying figures illustrate the method of use and the character of the results obtained.

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SOCIETIES AND ACADEMIES

ST. LOUIS ACADEMY OF SCIENCE

At a meeting of the St. Louis Academy of Science on March 20, 1916, Dr. A. R. Davis, of the Missouri Botanical Garden, presented a paper on "Enzyme Action in Marine Algæ," of which the following is an abstract:

During the years 1914–15 a general survey was made of the enzymes of certain representative marine algæ. The work was carried on for the most part at the Woods Hole Biological Laboratory since fresh, vigorously growing plants were obtainable in that immediate vicinity. Plants were also collected and carefully dried and with this material the work was further prosecuted at the Missouri Botanical Garden. All investigations where dried tissue was involved, however, were later duplicated with fresh material at Woods Hole. The standard methods of enzyme isolation and determination were employed and where negative results were obtained many modifications of these methods were brought to bear. In summarizing the results obtained, two striking points stand out, *i. e.*, the relative paucity of the number of enzymes demonstrable by standard methods, and the extraordinary slowness with which most of these enzymes act. Especially were both these points true for the "browns." In *Ascophyllum* and *Fucus* of this group catalase was the only enzyme demonstrable, while in *Laminaria* and *Mesoglœa* diastase, lipase, proteinases and catalase were found. Enzyme action was much more easily shown in the "reds" and the "greens" where in addition to the ferments found above, dextrinase, tryptase, ereptase and nuclease could be demonstrated. Oxidase was shown in but two forms, *Agardhiella* and *Ulva*. The rate of action in these two groups was also much faster than it was in the "browns," although here too, such action was slow when compared with that of many of the higher plants.

The carbohydrases found were those acting upon such polysaccharides as starch, glycogen, dextrin and laminarin—in no case any of the disaccharides employed being attacked. This latter fact is especially interesting in the light of the rôle maltose plays in the assimilation of the higher carbohydrates. Lipases and nucleases were quite widely distributed, and proteinases (tryptic and ereptic) were demonstrated in most of the forms investigated. Casein and peptone in neutral and slightly alkaline solution proved the most favorable substrates for these latter enzymes, although albumin and legumin were also hydrolyzed in certain instances. There was no digestion of algal protein, as shown by autolytic experiments, and no splitting of amino acids.

Several factors may enter in to account for the limited number of enzymes formed and the slowness of their action: (1) they may be formed in small amounts in the tissues, or as formed may be inherently slow; (2) inhibiting substances may be liberated upon crushing the cell which may cut down the rate of action or destroy it altogether. Evidence is at hand tending to show that both of these factors may be concerned.

J. M. Greenman,
Corresponding Secretary

SCIENCE

FRIDAY, SEPTEMBER 29, 1916

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

THE PRESENT POSITION AND FUTURE PROSPECTS OF THE CHEMICAL INDUSTRY IN GREAT BRITAIN[1]

FOR the third time in succession the Section meets under the shadow of the war cloud, but there is some slight consolation for the indescribable suffering and sorrow which have been imposed upon millions of our fellow creatures in the hope and belief that this cloud also may have a silver lining. It is perhaps no exaggeration to say that nothing less than such an upheaval of existing habits and traditions as has been caused by the war would have sufficed to arouse the British nation from the state of apathy towards science with which it has been fatuously contented in the past. Now, however, the sleeper has at least stirred in his slumber. The press bears witness, through the appearance of innumerable articles and letters, that the people of this country, and even the politicians, have begun to perceive the dangers which will inevitably result from a continuance of their former attitude, and to understand that in peace, as in war, civilization is at a tremendous disadvantage in the struggle for existence unless armed by science, and that the future prosperity of the empire is ultimately dependent upon the progress of science, and very specially of chemistry. If, as one result of the war, our people are led to appreciate the value of scientific work, then perhaps we shall not have paid too high a price, high although the price must be. As concerns our own branch of science,

[1] Address before the Chemical Section of the British Association for the Advancement of Science, Newcastle-on-Tyne, 1916.

we can not rest satisfied with anything less than full recognition of the fact that chemistry is a profession of fundamental importance, and that the chemist is entitled to a position in no respect inferior to that of a member of any of the other learned professions.

Reference to the annual reports of the association shows that former presidents of the Section have availed themselves to the full of the latitude permitted in the choice of a subject for their address, and that some have even established the precedent of dispensing with an address altogether. On the present occasion a topic for discussion seems to be clearly indicated by the circumstances in which we stand, because, since the outbreak of the war, chemists have been giving more earnest consideration than before to the present position and future prospects of the chemical industry of this country. It will, therefore, not be inappropriate if I touch upon some aspects of this question, even although unable to add much to what is, or ought to be, common knowledge.

The period which has elapsed since the last meeting of the Section in Newcastle has witnessed truly remarkable progress in every branch of pure and applied chemistry. For fully fifty years previous to that meeting the attention of the great majority of chemists had been devoted to organic chemistry, but since 1885 or thereabouts, whilst the study of the compounds of carbon has been pursued with unflagging energy and success, it has no longer so largely monopolized the activities of investigators. Interest in the other elements, which had been to some extent neglected on account of the fascinations of carbon, has been revived with the happiest results, for not only has our knowledge of these elements been greatly extended, but their number also has been notably increased by the discovery of two groups of simple substances possessed of new and remarkable properties—the inert gases of the argon family and the radio-active elements. In addition, the bonds between mathematics and physics, on the one hand, and chemistry, on the other, have been drawn closer, with the effect that the department of our science known as physical chemistry has now assumed a position of first-rate importance. With the additional light provided by the development and application of physico-chemical theory and methods, we are beginning to gain some insight into such intricate problems as the relation between physical properties and chemical constitution, the structure of molecules and even of atoms, and the mechanics of chemical change; our outlook is being widened, and our conceptions rendered more precise. Striking advances have also been made in other directions. The extremely difficult problems which confront the bio-chemist are being gradually overcome, thanks to the indefatigable labors of a band of highly skilled observers, and the department of biological chemistry has been established on a firm footing through the encouraging results obtained within the period under review. Further, within the last few years many of our ideas have been subjected to a revolutionary change through the study of the radio-active elements, those elusive substances which occur in such tantalizingly minute quantities, and of which some appear so reluctant to exist in a free and independent state that they merge their identity in that of another and less retiring relative within an interval of time measured by seconds. In truth, if a Rip Van Winkle among chemists were to awake now after a slumber of thirty years, his amazement on coming into contact with the chemistry of to-day would be beyond words.

The more purely scientific side of our science can claim no monopoly in progress, for applied chemistry, in every department,

has likewise advanced with giant strides, mainly of course through the application of the results of scientific research to industrial purposes. An attempt to sketch in the merest outline the recent development of applied chemistry would, I fear, exhaust your patience, but I may indicate in passing some of the main lines of advance. Many of the more striking results in the field of modern chemical industry have been obtained by taking advantage of the powers we now possess to carry out operations economically, both at very high and at very low temperatures, and by the employment on the manufacturing scale of electrolytic and catalytic methods of production. Thanks largely to the invention of the dynamo, the technologist is now able to utilize electrical energy both for the production of high temperatures in the different types of electric furnace and for electrolytic processes of the most varied description. Among the operations carried out with the help of the electric furnace may be mentioned the manufacture of graphite, silicon and phosphorus; of chromium and other metals; of carbides, silicides and nitrides, and the smelting and refining of iron and steel. Calcium carbide claims a prominent place in the list, in the first place because of the ease with which it yields acetylene, which is not only used as an illuminant, and, in the oxy-acetylene burner, as a means of producing a temperature so high that the cutting and welding of steel is now a comparatively simple matter, but also promises to serve as the starting-point for the industrial synthesis of acetaldehyde and many other valuable organic compounds. Moreover, calcium carbide is readily converted in the electric furnace into calcium cyanamide, which is employed as an efficient fertilizer in place of sodium nitrate or ammonium sulphate, and as a source of ammonia and of alkali cyanides. Among the silicides carborundum is increasingly used as an abrasive and a refractory material, and calcium silicide, which is now a commercial product, forms a constituent of some blasting explosives. The Serpek process for the preparation of alumina and ammonia, by the formation of aluminium nitride from beauxite in the electric furnace and its subsequent decomposition by caustic soda, should also be mentioned. Further, the electric furnace has made possible the manufacture of silica apparatus of all kinds, both for the laboratory and the works, and of alundum ware, also used for operations at high temperature. Finally, the first step in the manufacture of nitric acid and of nitrites from air, now in operation on a very large scale, is the combustion of nitrogen in the electric arc.

In other industrial operations the high temperature which is necessary is obtained by the help of the oxy-hydrogen or the oxy-acetylene flame, the former being used, amongst other purposes, in a small but I believe profitable industry, the manufacture of synthetic rubies, sapphires and spinels. Also, within a comparatively recent period, advantage has been taken of the characteristic properties of aluminium, now obtainable at a moderate price, in the various operations classed under the heading alumino-thermy, the most important being the reduction of refractory metallic oxides, although, of course, thermite is useful for the production of high temperatures locally.

The modern methods of liquefying gases, which have been developed within the period under review, have rendered possible research work of absorbing interest on the effect of very low temperatures on the properties and chemical activity of many substances, and have been applied, for instance, in separating from one another the members of the argon family, and in obtaining ozone in a state of prac-

tical purity. Moreover, industrial applications of these methods are not lacking, amongst which I may mention the separation of nitrogen and oxygen from air, and of hydrogen from water-gas—processes which have helped to make these elements available for economic use on the large scale.

Electrolytic methods are now extensively employed in the manufacture of both inorganic and organic substances, and older processes are being displaced by these modern rivals in steadily increasing number. It is sufficient to refer to the preparation of sodium, magnesium, calcium and aluminum, by electrolysis of fused compounds of these metals; the refining of iron, copper, silver and gold; the extraction of gold and nickel from solution; the recovery of tin from waste tin-plate; the preparation of caustic alkalies (and simultaneously of chlorine), of hypochlorites, chlorates and perchlorates, of hydrosulphites, of permanganates and ferricyanides, of persulphates and percarbonates; the regeneration of chromic acid from chromium salts; the preparation of hydrogen and oxygen. As regards organic compounds, we find chiefly in use electrolytic methods of reduction which are specially effective in the case of many nitro compounds, and of oxidation, as for instance the conversion of anthracene into anthraquinone. At the same time a number of other compounds, for example iodoform, are also prepared electrolytically.

Within recent years there have been great advances in the application of catalytic methods to industrial purposes. Some processes of this class have, of course, been in use for a considerable time, for example the Deacon chlorine process and the contact method for the manufacture of sulphuric acid, whilst the preparation of phthalic anhydride (largely used in the synthesis of indigo and other dyestuffs), by the oxidation of naphthalene with sulphuric acid with the assistance of mercuric sulphate as catalyst, is no novelty. More recent are the contact methods of obtaining ammonia by the direct combination of nitrogen and hydrogen, and of oxidizing ammonia to nitric acid—both of which are said to be in operation on a very large scale in Germany. The catalytic action of metals, particularly nickel and copper, is utilized in processes of hydrogenation—for example, the hardening of fats, and of dehydrogenation, as in the preparation of acetaldehyde from alcohol, and such metallic oxides as alumina and thoria can be used for processes of dehydration—*e. g.*, the preparation of ethylene or of ether from alcohol. Other catalysts employed in industrial processes are titanous chloride in electrolytic reductions and cerous sulphate in electrolytic oxidations of carbon compounds, gelatine in the preparation of hydrazine from ammonia, sodium in the synthesis of rubber, etc.

Other advances in manufacturing chemistry include the preparation of a number of the rarer elements and their compounds, which were hardly known thirty years ago, but which now find commercial applications. Included in this category are titanium, vanadium, tungsten and tantalum, now used in metallurgy or for electric-lamp filaments; thoria and ceria in the form of mantles for incandescent lamps; pyrophoric alloys of cerium and other metals; zirconia, which appears to be a most valuable refractory material; and compounds of radium and of mesothorium, for medical use as well as for research. Hydrogen, together with oxygen and nitrogen, are in demand for synthetic purposes, and the first also for lighter-than-air craft. Ozone is considerably used for sterilizing water and as an oxidizing agent, for example in the preparation of vanillin from isoeugenol and hydrogen peroxide, now obtainable

very pure in concentrated solution, and the peroxides of a number of the metals are also utilized in many different ways. The per- acids—perboric, percarbonic and persulphuric—or their salts are employed for oxidizing and bleaching purposes, and sodium hydrosulphite is much in demand as a reducing agent—*e. g.*, in dyeing with indigo. Hydroxylamine and hydrazine are used in considerable quantity, and the manufacture of cyanides by one or other of the modern methods has become quite an important industry, mainly owing to the use of the alkali salts in the cyanide process of gold extraction. These remarkable compounds, the metallic carbonyls, have been investigated, and nickel carbonyl is employed on the commercial scale in the extraction of the metal. Fine chemicals for analysis and research are now supplied, as a matter of course, in a state of purity rarely attained a quarter of a century ago.

In the organic chemical industry similar continued progress is to be noted. Accessions are constantly being made to the already enormous list of synthetic dyes, not only by the addition of new members to existing groups, but also by the discovery of entirely new classes of tinctorial compounds; natural indigo seems doomed to share the fate of alizarine from madder, and to be ousted by synthetic indigo, of which, moreover, a number of useful derivatives are also made. Synthetic drugs of all kinds—antipyrine and phenacetin, sulphonal and veronal, novacain and β-eucaine, salol and aspirin, piperazine and adrenaline, atoxyl and salvarsan—are produced in large quantities, as also are many synthetic perfumes and flavoring materials, such as ionone, heliotropine, and vanillin. Cellulose in the form of artificial silk is much used as a new textile material, synthetic camphor is on the market, synthetic rubber is said to be produced in considerable quantity; and the manufacture of materials for photographic work and of organic compounds for research purposes is no small part of the industry. However, it would serve no useful purpose to extend this catalogue, which might be done almost indefinitely.

British chemists are entitled to regard with satisfaction the part which they have taken in the development of scientific chemistry during the last three decades, as in the past, but with respect to the progress of industrial chemistry it must be regretfully admitted that, except in isolated cases, we have failed to keep pace with our competitors. Consider a single example. Although there still remain in South America considerable deposits of sodium nitrate which can be worked at a profit, it is clear that sooner or later other sources of nitric acid must be made available. The synthetic production of nitric acid from the air is now a commercial success; several different processes are in operation abroad, and Germany is reported to be quite independent of outside supplies. Electrical energy, upon the cost of which the success of the process largely depends, can be produced in this country at least as cheaply as in Germany, and yet we have done nothing in the matter, unless we count as something the appointment of a committee to consider possibilities. This case is only too typical of many others. A number of different causes have contributed to bring about this state of affairs, and the responsibility for it is assigned by some to the government, by others to the chemical manufacturers, and by still others to the professors of chemistry. I think, however, it will be generally admitted that the root of the matter is to be found in the general ignorance of and indifference to the methods and results of scientific work which characterize the people of this country. For many years past

our leaders in science have done all that lay in their power to awaken the country to the inevitable and deplorable results of this form of "sleeping sickness," but hitherto their reception has been much the same as that accorded to the hero of "The Pilgrim's Progress," as depicted in the following passage:

"He went on thus, even until he came at a bottom where he saw, a little out of the way, three Men fast asleep with Fetters upon their heels."

"The name of the one was *Simple*, another *Sloth*, and the third *Presumption*."

"Christian, then seeing them in this case, went to them, if peradventure he might awaken them. And cried, You are like them that sleep on the top of a Mast, for the Dead Sea is under you, a Gulf that hath no bottom. Awake therefore and come away; be willing also, and I will help you off with your irons. He also told them, If he that goeth about like a *Roaring Lion* comes by, you well certainly become a prey to his teeth."

"With that they lookt upon him, and began to reply in this sort: *Simple* said, *I see no danger; Sloth* said, *Yet a little more sleep;* and *Presumption* said, *Every Vat must stand upon his own bottom.* And they lay down to sleep again, and *Christian* went on his way."

I believe that a brighter day is dawning, and that, if only we rise to the occasion *now*, chemistry in this country will attain the position of importance which is its due. Meantime it is of no avail to lament lost opportunities or to indulge in unprofitable recrimination; on the contrary, it should be our business to find a remedy for the "arrested development" of our chemical industry, and the task of establishing remedial measures should be taken in hand by the state, the universities and the chemical manufacturers themselves. As regards another very large group of interested persons, the consumers of chemical products, or in other words the nation as a whole, it is surely not too much to expect that they have been taught by the course of events since the outbreak of the war the folly of depending solely upon foreign and possibly hostile manufacturers, even although fiscal and other advantages may enable the alien to undersell the home producer. Considering that the future prosperity of the empire depends largely upon the well-being of its chemical industries, it is simply suicidal to permit these to be crippled or even crushed out of existence by competition on unequal terms.

The government has taken a most significant step in advance by appointing an advisory council for scientific and industrial research and providing it with funds; incidentally, in so doing, it has recognized the past failure of the state to afford adequate support to scientific work. The advisory council has lost no time in getting to work and has already taken steps to allocate grants in support of a number of investigations of first-rate importance to industry. In order to be in a position to do justice to the branches of industry concerned in proposed researches which have been submitted by institutions and individuals it has decided to appoint standing committees of experts and has already constituted strong committees in mining, metallurgy and in engineering; a committee in chemistry will no doubt be appointed in due course. The council also makes the gratifying intimation that the training of an adequate supply of research workers will be an important part of its work.

It is safe to prophesy that the money expended by the advisory council will sooner or later yield a goodly return, and this justifies the hope that the government will not rest satisfied with their achievement,

but will take further steps in the same direction. This desire for continued action finds strong support in the recommendations made by a sub-committee of the advisory committee to the board of trade on commercial intelligence, which was appointed to report with respect to measures for securing the position, after the war, of certain branches of British industry. Of these recommendations I quote the following:

"1. *Scientific Industrial Research and Training.*—(*a*) Larger funds should be placed at the disposal of the new committee of the privy council, and also of the board of education, for the promotion of scientific and industrial training. (*b*) The universities should be encouraged to maintain and extend research work devoted to the main industry or industries located in their respective districts, and manufacturers engaged in these industries should be encouraged to cooperate with the universities in such work, either through their existing trade associations or through associations specially formed for the purpose. Such associations should bring to the knowledge of the universities the difficulties and needs of the industries, and give financial and other assistance in addition to that afforded by the state. In the case of non-localized industries trade associations should be advised to seek, in respect of centers for research, the guidance of the advisory committee of the privy council. (*c*) An authoritative record of consultant scientists, chemists and engineers and of persons engaged in industrial research, should be established and maintained by some suitable government department for the use of manufacturers only."

"2. *Tariff Protection.*—Where the national supply of certain manufactured articles which are of vital importance to the national safety or are essential to other industries has fallen into the hands of manufacturers or traders outside this country, British manufacturers ready to undertake the manufacture of such articles in this country should be afforded sufficient tariff protection to enable them to maintain such production after the war." (It is also recommended by the sub-committee that in view of the threatened dumping of stocks which may be accumulated in enemy countries, the government should take such steps as would prevent the position of industries, likely to be affected, being endangered after the war.)

"3. *Patents.*—(*a*) The efforts which have been made to secure uniformity of patent law throughout the empire should be continued. (*b*) The provisions of the law as to the compulsory working of patents in the United Kingdom should be more rigorously enforced, and inspectors should be appointed to secure that such working is complete and not only partial."

The adoption by the government of these weighty recommendations would go far to establish British chemical industry on a secure basis, and would undoubtedly lead to the expansion of already existing branches and the establishment of new ones. Meanwhile, the Australian government has set an example which might be followed with great advantage. Shortly after the British scheme for the development of scientific and industrial research under the auspices of the advisory council had been made public, the prime minister of Australia determined to do still more for the commonwealth, with the object of making it independent of German trade and manufactures after the conclusion of the war. He therefore appointed a committee representative of the state scientific departments, the universities, and industrial interests, and within a very short period the committee produced a scheme for the estab-

lishment of a Commonwealth Institute of Science and Industry. The institute is to be governed by three directors, two of whom will be scientific men of high standing, while the third will be selected for proved ability in business. The directors are to be assisted by an advisory council composed of nine representatives of science and of industry; these representatives are to seek information, advice and assistance from specialists throughout Australia. The chief functions of the institute are (1) To ascertain what industrial problems are most pressing and most likely to yield to scientific experimental investigation, to seek out the most competent men to whom such research may be entrusted, and to provide them with all the necessary appliances and assistance. (2) To build up a bureau of scientific and industrial information, which shall be at the service of all concerned in the industries and manufactures of the commonwealth. (3) To erect, staff and control special research laboratories, the first of which will probably be a physical laboratory somewhat on the lines of our National Physical Laboratory. Other functions of the institute are the coordination and direction of research and experimental work with a view to the prevention of undesirable overlapping of effort, the recommendation of grants of the commonwealth government in aid of pure scientific research in existing institutions, and the establishment and award of industrial research fellowships.

This admirable scheme is more comprehensive and more generous than that of our government, but it could be rivaled without much difficulty. We already possess an important asset in the National Physical Laboratory, and there now exists the advisory council with its extensive powers and duties. What is lacking in our scheme, so far as chemistry is concerned, could be made good, firstly, by providing the advisory council with much larger funds. and, secondly, by the establishment of a National Chemical Laboratory—an institute for research in pure and applied chemistry—or by assisting the development of research departments in our universities and technical colleges (as is now being done in America), or, better still, by moving in both directions. With respect to the second alternative, I do not mean to suggest that research work is neglected in the chemistry departments of any of our higher institutions; what I plead for is the provision of greater facilities for the prosecution of investigation not only in pure but also in applied chemistry. As things are at present, the professors and lecturers are for the most part so much occupied in teaching and in administration as to be unable to devote time uninterruptedly to research work, which demands above all things continuity of effort. The ideal remedy would be the institution of research professorships, but, failing this, the burden of teaching and administrative work should be lightened by appointing larger staffs.

It has been suggested by Dr. Forster that the state could render assistance to chemical industry in another way, namely, by the formation of a Chemical Intelligence Department of the Board of Trade, which should be concerned with technical, commercial and educational questions bearing upon the industry. Under the first head the proposed department would have the duty (*a*) of collecting, tabulating and distributing all possible information regarding chemical discoveries, patents, and manufacturing processes, and (*b*) of presenting problems for investigation to research chemists, of course under proper safeguards and with suitable remuneration. The more strictly commercial side of the department's activities would be concerned with the

classification of the resources of the empire as regards raw materials, and of foreign chemical products in respect of distribution throughout the world, with ruling prices, tariffs, cost of transport, and if possible cost of production. On the educational side it is suggested that the department should collect data regarding opportunities for chemical instruction and research in various parts of the empire, and should consider possible improvements and extensions of these. The department would of course be in charge of a highly trained chemist, with a sufficient number of chemical assistants.

This proposal, which has been widely discussed and on the whole very favorably received by chemists, has much to recommend it; to mention only one point, the unrivalled resources of the Board of Trade would facilitate the acquisition of information which might otherwise be difficult to obtain, or which would not be disclosed except to a government department. The principal objections which have been raised are based upon the fear that the proposed department, however energetic and enterprising it might be at the start, would soon be so helplessly gagged and bound down by departmental red tape as to become of little or no service. This danger, however, could be obviated to a great extent by the institution of a strong advisory committee, representative of and elected by the societies concerned with the different branches of chemistry, which would keep closely in touch with the Chemical Intelligence Department on the one hand and with the industry on the other, and which would act as adviser of the permanent scientific staff of the department. There is, I fear, little chance of seeing Dr. Forster's proposal carried into effect unless all the societies concerned move actively and unitedly in the matter; they must do the pioneer work and must submit a definite scheme to the government, if the desired result is to be attained. In the not improbable contingency that the board of trade will decline to take action, I trust that the scheme for the establishment of an Information Bureau—on lines similar to but somewhat less wide-reaching than those which I have just indicated—which has been under the careful consideration of the Council of the Society of Chemical Industry, will be vigorously prosecuted. Difficulties, chiefly financial, stand in the way, but these are not insuperable, especially if the sympathy and support of the government can be enlisted.

Unless the conditions and methods which have ruled in the past are greatly altered it is hardly possible to hope that the future prospects of our chemical industry will be bright; it is essential that the representatives of the industry should organize themselves in their own interest and cooperate in fighting the common enemy. More than ever is this the case when, as we are informed, three different groups of German producers of dyes, drugs and fine chemicals, who own seven large factories, have formed a combination with a capital of more than £11,000,000, and with other assets of very great value in the shape of scientific, technical and financial efficiency. Hence it is eminently satisfactory to be able to record the active progress of a movement, originated by the Chemical Society, which has culminated in the formation of an Association of British Chemical Manufacturers. The main objects of the association are to promote cooperation between British chemical manufacturers; to act as a medium for placing before the government and government officials the views of manufacturers upon matters affecting the chemical industry; to develop technical organization and promote industrial research; to keep in

touch with the progress of chemical knowledge and to facilitate the development of new British industries and the extension of existing ones; and to encourage the sympathetic association of British manufacturers with the various universities and technical colleges.

Needless to say, the progress of this important movement will be assisted by everyone who is interested, either directly or indirectly, in the welfare of our chemical industry, and, moreover, the support of the scientific societies will not be lacking, for, as the result of a conference convened by the President and Council of the Royal Society, a Conjoint Board of Scientific Societies has been constituted, for the furtherance of the following objects: Promoting the cooperation of those interested in pure or applied science; supplying a means whereby scientific opinion may find effective expression on matters relating to science, industry and education; taking such action as may be necessary to promote the application of science to our industries and to the service of the nation; and discussing scientific questions in which international cooperation seems advisable.

In an address given to the Society of Chemical Industry last year, I indicated another way in which chemical manufacturers can help themselves and at the same time promote the interests of chemistry in this country. In the United States of America individual manufacturers, or associations of manufacturers, have shown themselves ready to take up the scheme originated by the late Professor Duncan for the institution of industrial research scholarships tenable at the universities or technical colleges, and the results obtained after ten years' experience of the working of this practical method of promoting cooperation between science and industry have more than justified the anticipations of its originator. The scheme is worthy of adoption on many grounds, of which the chief are that it provides definite subjects for technical research to young chemists qualified for such work, that it usually leads to positions in factories for chemists who have proved their capacity through the work done while holding scholarships, and that it reacts for good on the profession generally, by bringing about that more intimate intercourse between teachers and manufacturers which is so much to be desired.

In this connection the recent foundation of the Willard Gibbs chair of research in pure chemistry at the University of Pittsburgh is extremely significant, for it shows that even in such a purely industrial community as Pittsburgh it is recognized that the most pressing need of the day is the endowment of chemical research and the creation of research professorships. Mr. A. P. Fleming, who recently made a tour of inspection of research laboratories in the United States, points to the amount of work done by individual firms and the increased provision now being made for research in universities and technical institutions. He reports that at the present time there are upwards of fifty corporations having research laboratories, costing annually from £20,000 to £100,000 for maintenance, and states that "some of the most striking features of the research work in America are the lavish manner in which the laboratories have been planned, which in many cases enables large scale operations to be carried out in order to determine the best possible methods of manufacturing any commodity developed or discovered in the laboratories; the increasing attention given in the research laboratories to pure science investigation, this being, in my opinion, the most important phase of industrial research; and the absorption of

men who have proved their capacity for industrial research in such places as the Mellon Institute, the Bureau of Standards, etc., by the various industries in which they have taken scientific interest." It is evidently the view of American manufacturers that industrial research can be made to pay for itself, and that to equip and maintain research laboratories is an excellent investment.

It can not be too often reiterated that no branch of chemical industry can afford to stand still, for there is no finality in manufacturing processes; all are capable of improvement, and for this, as well as for the discovery and the application of new processes, the services of the trained chemist are essential. Hence the training of chemists for industrial work is a matter of supreme importance. We may therefore congratulate ourselves that the opportunities for chemical instruction in this country are immensely greater than they were thirty years ago. The claims of chemistry to a leading position have been recognized by all our universities, even the most ancient, by the provision of teaching staffs, laboratories, and equipment on a fairly adequate if not a lavish scale, and in this respect many of the technical colleges fall not far behind. The evening classes conducted in a large number of technical institutions are hardly fitted to produce fully trained chemists, if only because lack of the necessary time prevents the student from obtaining that prolonged practise in the laboratory which cannot be dispensed with, unless indeed he is prepared to go through a course of study extending over many years. At the same time these evening classes play a most important part, firstly in disseminating a knowledge of chemistry throughout the country, and secondly in affording instruction of a high order in special branches of applied chemistry. Finally, in a large and increasing number of schools a more or less satisfactory introduction to the science is given by well-qualified teachers. With our national habit of self-depreciation we are apt to overlook the steady progress which has been made, but at the same time I do not suggest that there is no room for improvement of our system of training chemists. Progress in every department of industrial chemistry is ultimately dependent upon research, and therefore a sufficient supply of chemists with practical knowledge and experience of the methods of research is vital. This being so, it is an unfortunate thing that so many students are allowed to leave the universities in possession of a science degree but without any experience in investigation. The training of the chemist, so far as that training can be given in a teaching institution, must be regarded as incomplete unless it includes some research work, not, of course, because every student has the mental gifts which characterize the born investigator, but rather because of the inestimable value of the experience gained when he has to leave the beaten track and to place more dependence upon his own initiative and resource. Consequently one rejoices to learn that at the University of Oxford no candidate can now obtain an honors degree without having produced evidence that he has taken part in original research, and that the General Board of Studies at Cambridge has also made proposals which, if adopted, will have the effect of encouraging systematic research work. Perhaps it is too much to expect that practise in research will be made an indispensable qualification for the ordinary degree; failing this, and indeed in every case, promising students should be encouraged, by the award of research scholarships, to continue their studies for a period of at least two years after taking

the B.Sc. degree, and to devote that time to research work which would qualify for a higher degree. In this connection an excellent object-lesson is at hand, for the output of research work from the Scottish universities has very greatly increased since the scheme of the Carnegie Trust for the institution of research scholarships has come into operation. Thanks to these scholarships, numbers of capable young graduates, who otherwise for the most part would have had to seek paid employment as soon as their degree courses were completed, have been enabled to devote two or more years to research work. Of course it must be recognized that not every chemist has the capacity to initiate or inspire investigation, and that no amount of training, however thorough and comprehensive, will make a man an investigator unless he has the natural gift. At the same time, whilst only the few are able to originate really valuable research work, a large army of disciplined men who have had training in the methods of research is required to carry out experimentally the ideas of the master mind. Moreover, there is ample scope in industrial work for chemists who, although not gifted with initiative as investigators, are suitably equipped to supervise and control the running of large-scale processes, the designing of appropriate plant, the working out on the manufacturing scale of new processes or the improvement of existing ones—men of a thoroughly practical mind, who never lose sight of costs, output and efficiency, and who have a sufficient knowledge of engineering to make their ideas and suggestions clear to the engineering expert. Further, there has to be considered the necessity for the work of the skilled analyst in the examination of raw materials and the testing of intermediate and finished products, although much of the routine work of the industrial laboratory will advisedly be left in the hands of apprentices working under the control of the chemist. Lastly, for the buying and selling of materials there should be a demand for the chemist with the commercial faculty highly developed. There is, indeed, in any large industrial establishment room for chemists of several different types, but all of these should have had the best possible training, and it must be the business of our higher teaching institutions to see that this training is provided.

On more than one occasion I have expressed the opinion that every chemist who looks forward to an industrial post should receive in the course of his training a certain amount of instruction in chemical engineering, by means of lectures and also of practical work in laboratories fitted out for the purpose. The practicability of this has been proved in more than one teaching institution, and experience has convinced me that chemists who have had such a course are generally more valuable in a works—whether their ultimate destination is the industrial research laboratory or the control of manufacturing operations—than those who have not had their studies directed beyond the traditional boundaries of pure chemistry. (I used the word "traditional" because to my mind there is no boundary line between the domains of pure and of applied chemistry.) A course in chemical engineering, preferably preceded by a short course in general engineering and drawing, must, however, be introduced as *a supplement to,* and not as *a substitute for,* any part of the necessary work in pure chemistry, and consequently the period of undergraduate study will be lengthened if such a course is included; this is no disadvantage, but quite the contrary. I am glad to say that the University of Glasgow has recently instituted a degree in applied chemistry, for which the curriculum in-

cludes chemical engineering in addition to the usual courses in chemistry, and I hope that a place will be found for this subject by other universities.

On the whole, there is not much fault to be found with the training for chemists supplied by the universities and technical colleges, but there is still room for improvements which could and would be carried out if it were not that the scientific departments of these institutions are as a rule hampered by lack of funds. The facilities for practical instruction with respect to accommodation and equipment are generally adequate, but, on the other hand, the *personnel* could with advantage be largely increased, and at least the junior members of the staffs are miserably underpaid. It would doubtless be regarded as insanity to suggest that a scientific man, however eminent, should receive more than a fraction of the salary to which a music-hall "artiste" or a lawyer politician can aspire; but if the best brains in the country are to be attracted towards science, as they ought to be, some greater inducement than a mere living wage should be held out. Hence no opportunity should be lost of impressing upon the government the necessity for increasing the grants to the scientific departments of our higher teaching institutions, and for the provision of research scholarships. It is much to be desired also that wealthy men in this country should take an example from America and acquire more generally the habit of devoting some part of their means to the endowment of higher education. The private donations for science and education made in the United States during the last forty-three years amount to the magnificent sum of £117,000,000, and recently the average annual benefactions for educational purposes total nearly £6,000,000. Of course there are few, if any, of the universities and colleges in this country which are not deeply indebted to the foresight and generosity of private benefactors, but the lavish scale on which funds are provided in America leads to a certain feeling of admiring envy.

After all, the chief difficulty which confronts those who are eager for progress in educational matters is that so many of our most famous schools are still conducted on medieval lines, in the sense that the "education" administered is almost wholly classical. Consequently, "though science enters into every part of modern life, and scientific method is necessary for success in all undertakings, the affairs of the country are in the hands of legislators who not only have little or no acquaintance with the fundamental facts and principles signified by these aspects of knowledge, but also do not understand how such matters can be used to strengthen and develop the state. Our administrative officials are also mostly under the same disabilities, on account of their want of a scientific training. They are educated at schools where science can receive little encouragement, and they do not take up scientific subjects in the examinations for the civil service, because marks can be much more easily obtained by attention to Latin and Greek; and the result of it all is that science is usually treated with indifference, often with contempt, and rarely with intelligent appreciation by the statesmen and members of the public services whose decisions and acts largely determine the country's welfare. The defects of a system which places the chief power of an organization which needs understanding of science in every department in the hands of people who have not received any training in scientific subjects or methods are obvious."[2] The remedy is also obvious.

Here, again, the prospects are now

[2] *Nature*, February 10, 1916.

brighter than ever before, because the warnings and appeals of men of science have at last, and after many years, begun to bear fruit, or perhaps it would be more correct to say the lessons of the war have begun to make an impression on the powers that be. Within the last few weeks it has been intimated that the government, giving ear to what has been uttered, incessantly and almost *ad nauseam,* with regard to British neglect of science, proposes to appoint a committee to inquire into the position of science in our national system of education, especially in universities and secondary schools. The duty of the committee will be to advise the authorities how to promote the advancement of pure science, and also the interests of trade, industries and professions dependent on the application of science, bearing in mind the needs of what is described as a liberal education. It is stated that the committee will include scientific men in whom the country will have confidence, some of those who appreciate the application of science to commerce and industry, and some who are able from general experience to correlate scientific teaching with education as a whole. I am sure that we may look forward with confidence to the recommendations of such a committee, and we shall hope, for the sake of our country, that their recommendations will be adopted and put in force with the least possible delay.

G. G. Henderson

NEW ARCHEOLOGICAL LIGHTS ON THE ORIGIN OF CIVILIZATION IN EUROPE. II

It is a commonplace of archeology that the culture of the Neolithic peoples throughout a large part of central, northern and western Europe—like the newly domesticated species possessed by them—is Eurasiatic in type. So, too, in southern Greece and the Ægean world we meet with a form of Neolithic culture which must be essentially regarded as a prolongation of that of Asia Minor.

It is clear that it is on this Neolithic foundation that our later civilization immediately stands. But in the constant chain of actions and reactions by which the history of mankind is bound together—short of the extinction of all concerned, a hypothesis in this case excluded—it is equally certain that no great human achievement is without its continuous effect. The more we realize the substantial amount of progress of the men of the Late Quaternary Age in arts and crafts and ideas, the more difficult it is to avoid the conclusion that somewhere "at the back of behind"—it may be by more than one route and on more than one continent, in Asia as well as Africa—actual links of connection may eventually come to light.

Of the origins of our complex European culture this much at least can be confidently stated: the earliest extraneous sources on which it drew lay respectively in two directions—in the valley of the Nile, on one side, and in that of the Euphrates, on the other.

Of the high early culture in the lower Euphrates valley our first real knowledge has been due to the excavations of De Sarzec in the mounds of Tello, the ancient Lagash. It is now seen that the civilization that we call Babylonian, and which was hitherto known under its Semitic guise, was really in its main features an inheritance from the earlier Sumerian race—culture in this case once more dominating nationality. Even the laws which Hammurabi traditionally received from the Babylonian Sun God were largely modelled on the reforms enacted a thousand years earlier by his predecessor, Urukagina, and ascribed by him to the inspira-

tion of the City God of Lagash.[10] It is hardly necessary to insist on the later indebtedness of our civilization to this culture in its Semitized shape, as passed on, together with other more purely Semitic elements, to the Mediterranean world through Syria, Canaan and Phœnicia, or by way of Assyria, and by means of the increasing hold gained on the old Hittite region of Anatolia.

Even beyond the ancient Mesopotamian region which was the focus of these influences, the researches of De Morgan, Gautier and Lampre, of the French "Délégation en Perse," have opened up another independent field, revealing a nascent civilization equally ancient, of which Elam—the later Susiana—was the center. Still further afield, moreover—some three hundred miles east of the Caspian—the interesting investigations of the Pumpelly Expedition in the mounds of Anau, near Ashkabad in southern Turkestan, have brought to light a parallel and related culture. The painted Neolithic sherds of Anau, with their geometrical decoration, similar to contemporary ware of Elam, have suggested wide comparisons with the painted pottery of somewhat later date found in Cappadocia and other parts of Anatolia, as well as in the North Syrian regions. It has, moreover, been reasonably asked whether another class of painted Neolithic fabrics, the traces of which extend across the steppes of southern Russia, and, by way of that ancient zone of migration, to the lower Danube and northern Greece, may not stand in some original relation to the same ancient province. The new discoveries, however, in the mounds of Elam and Anau have at most a bearing on the primitive phase of culture in parts of southeastern Europe that preceded the age when metal was generally in use.

10 See L. W. King, "History of Sumer and Akkad," p. 184.

Turning to the Nile Valley we are again confronted with an extraordinary revolution in the whole point of view effected during recent years. Thanks mainly to the methodical researches initiated by Flinders Petrie, we are able to look back beyond the Dynasties to the very beginnings of Egyptian civilization. Already by the closing phase of the Neolithic and by the days of the first incipient use of metals the indigenous population had attained an extraordinarily high level. If, on the one hand, it displays Libyan connections, on the other, we already note the evidences of commercial intercourse with the Red Sea; and the constant appearance of large rowing vessels in the figured designs shows that the Nile itself was extensively used for navigation. Flint-working was carried to unrivalled perfection, and special artistic refinement was displayed in the manufacture of vessels of variegated breccia and other stones. The antecedent stages of many Egyptian hieroglyphs are already traceable, and the cult of Egyptian divinities, like Min, was already practised. Whatever ethnic change may have marked the establishment of Pharaonic rule, here, too, the salient features of the old indigenous culture were taken over by the new régime. This early dynastic period itself has also received entirely new illustration from the same researches, and the freshness and force of its artistic works in many respects outshine anything produced in the later course of Egyptian history.

The continuity of human tradition, as a whole, in areas geographically connected like Eurafrica, on the one side, and Eurasia, on the other, has been here postulated. Since, as we have seen, the Late Palæolithic culture was not violently extinguished but shows signs of survival, both north and south, we are entitled to trace elements of direct derivation from this source among the inherited acquire-

ments that finally led up to the higher forms of ancient civilization that arose on the Nile and the Euphrates. In many directions, we may believe, the flaming torch had been carried on by the relay runners.

But what, it may be asked, of Greece itself, where human culture reached its highest pinnacle in the ancient world and to which we look as the principal source of our own civilization?

Till within recent years it seemed almost a point of honor for classical scholars to regard Hellenic civilization as a Wonder-Child, sprung, like Athena herself, fully panoplied from the head of Zeus. The indebtedness to Oriental sources was either regarded as comparatively late or confined to such definite borrowings as the alphabet or certain weights and measures. Egypt, on the other hand, at least till Alexandrine times, was looked on as something apart, and it must be said that Egyptologists, on their side, were only too anxious to preserve their sanctum from profane contact.

A truer perspective has now been opened out. It has been made abundantly clear that the rise of Hellenic civilization was itself part of a wider economy and can be no longer regarded as an isolated phenomenon. Indirectly, its relation to the greater world and to the ancient centers to the south and east has been now established by its affiliation to the civilization of prehistoric Crete and by the revelation of the extraordinarily high degree of proficiency that was there attained in almost all departments of human art and industry. That Crete itself—the "Mid-Sea land," a kind of halfway house between three continents—should have been the cradle of our European civilization was, in fact, a logical consequence of its geographical position. An outlier of mainland Greece, almost opposite the mouths of the Nile, primitive intercourse between Crete and the further shores of the Libyan Sea was still further facilitated by favorable winds and currents. In the eastern direction, on the other hand, island stepping-stones brought it into easy communication with the coast of Asia Minor, with which it was actually connected in late geological times.

But the extraneous influences that were here operative from a remote period encountered on the island itself a primitive indigenous culture that had grown up there from immemorial time. In view of some recent geological calculations, such as those of Baron De Geer, who by counting the number of layers of mud in Lake Ragunda has reduced the ice-free period in Sweden to 7,000 years, it will not be superfluous to emphasize the extreme antiquity that seems to be indicated for even the later Neolithic in Crete. The Hill of Knossos, upon which the remains of the brilliant Minoan civilization have found their most striking revelation, itself resembles in a large part of its composition a great mound or tell—like those of Mesopotamia or Egypt—formed of layer after layer of human deposits. But the remains of the whole of the later ages represented down to the earliest Minoan period (which itself goes back to a time contemporary with the early Dynasties of Egypt—at a moderate estimate to B.C. 3400) occupy considerably less than a half—19 feet, that is, out of a total of over 45. Such calculations can have only a relative value, but, even if we assume a more rapid accumulation of débris for the Neolithic strata and deduct a third from our calculation, they would still occupy a space of over 3,400 years, giving a total antiquity of some 9,000 years from the present time.[11] No Neolithic section in Europe can compare in extent with that of Knossos, which itself can be divided by the character of its con-

[11] For a fuller statement I must refer to my forthcoming work, "The Nine Minoan Periods" (Macmillans), Vol. I.: Neolithic Section.

tents into an Early, Middle and Late phase. But its earliest stratum already shows the culture in an advanced stage, with carefully ground and polished axes and finely burnished pottery. The beginnings of Cretan Neolithic must go back to a still more remote antiquity.

The continuous history of the Neolithic Age is carried back at Knossos to an earlier epoch than is represented in the deposits of its geographically related areas on the Greek and Anatolian side. But sufficient materials for comparison exist to show that the Cretan branch belongs to a vast province of primitive culture that extended from southern Greece and the Ægean islands throughout a wide region of Asia Minor and probably still further afield.

An interesting characteristic is the appearance in the Knossian deposits of clay images of squatting female figures of a pronouncedly steatopygous conformation and with hands on the breasts. These in turn fit on to a large family of similar images which recur throughout the above era, though elsewhere they are generally known in their somewhat developed stage, showing a tendency to be translated into stone, and finally—perhaps under extraneous influences both from the north and east—taking a more extended attitude. These clearly stand in a parallel relationship to a whole family of figures with the organs of maternity strongly developed that characterize the Semitic lands and which seem to have spread from there to Sumeria and to the seats of the Anau culture.

At the same time this steatopygous family, which in other parts of the Mediterranean basin ranges from prehistoric Egypt and Malta to the north of mainland Greece, calls up suggestive reminiscences of the similar images of Aurignacian Man. It is especially interesting to note that in Crete, as in the Anatolian region where these primitive images occur, the worship of a Mother Goddess predominated in later times, generally associated with a divine child—a worship which later survived in a classical guise and influenced all later religion. Another interesting evidence of the underlying religious community between Crete and Asia Minor is the diffusion in both areas of the cult of the Double Axe. This divine symbol, indeed, or "Labrys," became the special emblem of the Palace sanctuary of Knossos itself, which owes to it its traditional name of Labyrinth. I have already called attention to the fact that the absorptive and disseminating power of the Roman Empire brought the cult of a male form of the divinity of the Double Axe to the Roman Wall and to the actual site on which Newcastle stands.

The fact should never be left out of sight that the gifted indigenous stock which in Crete eventually took to itself, on one hand and the other, so many elements of exotic culture, was still deep-rooted in its own. It had, moreover, the advantages of an insular people in taking what it wanted and no more. Thus it was stimulated by foreign influences but never dominated by them, and there is nothing here of the servility of Phœnician art. Much as it assimilated, it never lost its independent tradition.

It is interesting to note that the first quickening impulse came to Crete from the Egyptian and not from the Oriental side—the eastern factor, indeed, is of comparatively late appearance. My own researches have led me to the definite conclusion that cultural influences were already reaching Crete from beyond the Libyan Sea before the beginning of the Egyptian dynasties. These primitive influences are attested, amongst other evidences, by the forms of stone vessels, by the same esthetic tradition in the selection of materials distinguished by their polychromy, by the ap-

pearance of certain symbolic signs, and the subjects of shapes and seals which go back to prototypes in use among the "Old Race" of the Nile Valley. The impression of a very active agency indeed is so strong that the possibility of some actual immigration into the island of the older Egyptian element, due to the conquests of the first Pharaohs, can not be excluded.

The continuous influence of Dynastic Egypt from its earliest period onwards is attested both by objects of import and their indigenous imitations, and an actual monument of a middle empire Egyptian was found in the Palace Court at Knossos. More surprising still are the cumulative proofs of the reaction of this early Cretan civilization on Egypt itself, as seen not only in the introduction there of such beautiful Minoan fabrics as the elegant polychrome vases, but in the actual impress observable on Egyptian art even on its religious side. The Egyptian griffin is fitted with Minoan wings. So, too, on the other side we see the symbols of Egyptian religion impressed into the service of the Cretan Nature Goddess, who in certain respects was partly assimilated with Hathor, the Egyptian Cow-Goddess of the Underworld.

My own most recent investigations have more and more brought home to me the all-pervading community between Minoan Crete and the land of the Pharaohs. When we realize the great indebtedness of the succeeding classical culture of Greece to its Minoan predecessor the full significance of this conclusion will be understood. Ancient Egypt itself can no longer be regarded as something apart from general human history. Its influences are seen to lie about the very cradle of our own civilization.

The high early culture, the equal rival of that of Egypt and Babylonia, which thus began to take its rise in Crete in the fourth millennium before our era, flourished for some two thousand years, eventually dominating the Ægean and a large part of the Mediterranean basin. To the civilization, as a whole, I ventured, from the name of the legendary king and law-giver of Crete, to apply the name of "Minoan," which has received general acceptance; and it has been possible now to divide its course into three ages—Early, Middle and Late, answering roughly to the successive Egyptian kingdoms, and each in turn with a triple subdivision.

It is difficult indeed in a few words to do adequate justice to this earliest of European civilizations. Its achievements are too manifold. The many-storeyed palaces of the Minoan priest-kings in their great days, by their ingenious planning, their successful combination of the useful with the beautiful and stately, and, last but not least, by their scientific sanitary arrangements, far outdid the similar works, on however vast a scale, of Egyptian or Babylonian builders. What is more, the same skilful and commodious construction recurs in a whole series of private mansions and smaller dwellings throughout the island. Outside "broad Knossos" itself, flourishing towns sprang up far and wide on the country sides. New and refined crafts were developed, some of them, like that of the inlaid metal-work, unsurpassed in any age or country. Artistic skill, of course, reached its acme in the great palaces themselves, the corridors, landings and porticoes of which were decked with wall paintings and high reliefs, showing in the treatment of animal life not only an extraordinary grasp of nature, but a grandiose power of composition such as the world had never seen before. Such were the great bull-grappling reliefs of the Sea Gate at Knossos and the agonistic scenes of the great palace hall.

The modernness of much of the life here revealed to us is astonishing. The elabora-

tion of the domestic arrangements, the staircases story above story, the front places given to the ladies at shows, their fashionable flounced robes and jackets, the gloves sometimes seen on their hands or hanging from their folding chairs, their very mannerisms as seen on the frescoes, pointing their conversation with animated gestures—how strangely out of place would it all appear in a classical design! Nowhere, not even at Pompeii, have more living pictures of ancient life been called up for us than in the Minoan Palace of Knossos. The touches supplied by its closing scene are singularly dramatic—the little bath-room opening out of the Queen's parlor, with its painted clay bath, the royal draught-board flung down in the court, the vessels for anointing and the oil-jar for their filling ready to hand by the throne of the Priest-King, with the benches of his Consistory round and the sacred griffins on either side. Religion, indeed, entered in at every turn. The palaces were also temples, the tomb a shrine of the Great Mother. It was perhaps owing to the religious control of art that among all the Minoan representations—now to be numbered by thousands—no single example of indecency has come to light.

A remarkable feature of this Minoan civilization can not be passed over. I remember that at the Liverpool meeting of this association in 1896—just before the first results of the new discoveries in Crete were known—a distinguished archeologist took as the subject of an evening lecture "Man before Writing," and, as a striking example of a high culture attained by "*Analfabeti,*" singled out that of Mycenæ—a late offshoot, as we know now, from Minoan Crete. To such a conclusion, based on negative evidence, I confess I could never subscribe—for had not even the people of the Reindeer Age attained to a considerable proficiency in expression by means of symbolic signs? To-day we are able to trace the gradual evolution on Cretan soil of a complete system of writing from its earliest pictographic shape, through a conventionalized hieroglyphic to a linear stage of great perfection. In addition to inscribed sealings and other records some two thousand clay tablets have now come to light, mostly inventories or contracts; for though the script itself is still undeciphered the pictorial figures that often appear on these documents supply a valuable clue to their contents. The numeration also is clear, with figures representing sums up to 10,000. The inscribed sealings, signed, counter-marked and counter-signed by controlling officials, give a high idea of the elaborate machinery of government and administration under the Minoan rulers.

The minutely organized legal conditions to which this points confirm the later traditions of Minos, the great law-giver of prehistoric Crete, who, like Hammurabi and Moses, was said to have received the law from the God of the Sacred Mountain. The clay tablets themselves were certainly due to Oriental influences, which make themselves perceptible in Crete at the beginning of the Late Minoan Age, and may have been partly resultant from the reflex action of Minoan colonization in Cyprus. From this time onwards eastern elements are more and more traceable in Cretan culture, and are evidenced by such phenomena as the introduction of chariots—themselves perhaps more remotely of Aryan-Iranian derivation—and by the occasional use of cylinder seals.

Simultaneously with its eastern expansion, which affected the coast of Phœnicia and Palestine as well as Cyprus, Minoan civilization now took firm hold of mainland Greece, while traces of its direct influence are found in the west Mediterranean basin—in Sicily, the Balearic Islands and Spain.

At the time of the actual conquest and during the immediately succeeding period the civilization that appears at Mycenæ and Tiryns, at Thebes and Orchomenos, and at other centers of mainland Greece, though it seems to have brought with it some already assimilated Anatolian elements, is still in the broadest sense Minoan. It is only at a later stage that a more provincial offshoot came into being to which the name Mycenæan can be properly applied. But it is clear that some vanguard at least of the Aryan Greek immigrants came into contact with this high Minoan culture at a time when it was still in its most flourishing condition. The evidence of Homer itself is conclusive. Arms and armor described in the poems are those of the Minoan prime, the fabled shield of Achilles, like that of Herakles described by Hesiod, with its elaborate scenes and variegated metal-work, reflects the masterpieces of Minoan craftsmen in the full vigor of their art; the very episodes of epic combat receive their best illustration on the signets of the great days of Mycenæ. Even the lyre to which the minstrel sang was a Minoan invention. Or, if we turn to the side of religion, the Greek temple seems to have sprung from a Minoan hall, its earliest pediment schemes are adaptations from the Minoan tympanum—such as we see in the Lions' Gate—the most archiac figures of the Hellenic Goddesses, like the Spartan Orthia, have the attributes and attendant animals of the great Minoan Mother.

Some elements of the old culture were taken over on the soil of Hellas. Others which had been crushed out in their old centers survived in the more eastern shores and islands formerly dominated by Minoan civilization, and were carried back by Phœnician or Ionian intermediaries to their old homes. In spite of the overthrow which about the twelfth century before our era fell on the old Minoan dominion and the onrush of the new conquerors from the north, much of the old tradition still survived to form the base for the fabric of the later civilization of Greece. Once more, through the darkness, the lighted torch was carried on, the first glimmering flame of which had been painfully kindled by the old Cave dwellers in that earlier Palæolithic world.

The Roman Empire, which in turn appropriated the heritage that Greece had received from Minoan Crete, placed civilization on a broader basis by welding together heterogeneous ingredients and promoting a cosmopolitan ideal. If even the primeval culture of the Reindeer Age embraced more than one race and absorbed extraneous elements from many sides, how much more is that the case with our own which grew out of the Greco-Roman! Civilization in its higher form to-day, though highly complex, forms essentially a unitary mass. It has no longer to be sought out in separate luminous centers, shining like planets through the surrounding night. Still less is it the property of one privileged country or people. Many as are the tongues of mortal men, its votaries, like the Immortals, speak a single language. Throughout the whole vast area illumined by its quickening rays, its workers are interdependent, and pledged to a common cause.

We, indeed, who are met here to-day to promote in a special way the Cause of Truth and Knowledge, have never had a more austere duty set before us. I know that our ranks are thinned. How many of those who would otherwise be engaged in progressive research have been called away for their country's service! How many who could least be spared were called to return no more! Scientific intercourse is broken, and its cosmopolitan character is obscured by the death struggle in which whole continents are locked. The concentration, moreover, of the nation and of its

government on immediate ends has distracted it from the urgent reforms called for by the very evils that are the root cause of many of the greatest difficulties it has had to overcome. It is a lamentable fact that beyond any nation of the west the bulk of our people remains sunk not in comparative ignorance only—for that is less difficult to overcome—but in intellectual apathy. The dull incuria of the parents is reflected in the children, and the desire for the acquirement of knowledge in our schools and colleges is appreciably less than elsewhere. So, too, with the scientific side of education, it is not so much the actual amount of science taught that is in question—insufficient as that is—as the instillation of the scientific spirit itself—the perception of method, the sacred thirst for investigation.

But can we yet despair of the educational future of a people that has risen to the full height of the great emergency with which they were confronted? Can we doubt that, out of the crucible of fiery trial, a New England is already in the moulding?

We must all bow before the hard necessity of the moment. Of much we can not judge. Great patience is demanded. But let us, who still have the opportunity of doing so, at least prepare for the even more serious struggle that must ensue against the enemy in our midst, that gnaws our vitals. We have to deal with ignorance, apathy, the non-scientific mental attitude, the absorption of popular interest in sports and amusements.

And what, meanwhile, is the attitude of those in power—of our government, still more of our permanent officials? A cheap epigram is worn threadbare in order to justify the ingrained distrust of expert, in other words of scientific, advice on the part of our public offices. We hear, indeed, of "Commissions" and "Enquiries," but the inveterate attitude of our rulers towards the higher interests that we are here to promote is too clearly shown by a single episode. It is those higher interests that are the first to be thrown to the wolves. All are agreed that special treasures should be stored in positions of safety, but at a time when it might have been thought desirable to keep open every avenue of popular instruction and of intelligent diversion, the galleries of our National Museum at Bloomsbury were entirely closed for the sake of the paltriest saving—three minutes, it was calculated, of the cost of the war to the British treasury! That some, indeed, were left open elsewhere was not so much due to the enlightened sympathy of our politicians, as to their alarmed interests in view of the volume of intelligent protest. Our friends and neighbors across the Channel, under incomparably greater stress, have acted in a very different spirit.

It will be a hard struggle for the friends of science and education and the air is thick with mephitic vapors. Perhaps the worst economy to which we are to-day reduced by our former lack of preparedness is the economy of truth. Heaven knows!—it may be a necessary penalty. But its results are evil. Vital facts that concern our national well-being, others that even affect the cause of a lasting peace, are constantly suppressed by official action. The negative character of the process at work which conceals its operation from the masses makes it the more insidious. We live in a murky atmosphere amidst the suggestion of the false, and there seems to be a real danger that the recognition of truth as itself a tower of strength may suffer an eclipse.

It is at such a time and under these adverse conditions that we, whose object it is to promote the advancement of science, are called upon to act. It is for us to see to it that the lighted torch handed down to us

from the ages shall be passed on with a still brighter flame. Let us champion the cause of education, in the best sense of the word, as having regard to its spiritual as well as its scientific side. Let us go forward with our own tasks, unflinchingly seeking for the truth, confident that, in the eternal dispensation, each successive generation of seekers may approach nearer to the goal.

Magna est veritas, et prævalebit.

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THE IMPORTANCE OF SCIENTIFIC RESEARCH TO THE INDUSTRIES

AMERICA is in the throes of preparedness and many are the remedies offered for quick deliverance. These remedies are of two varieties, namely, genuine and quack; and at times it may be difficult to dissociate one from the other.

Schemes of all kinds are offered purporting to be of immediate and direct value in the program of national defense, but when sifted to the bottom are found to be, either wholly valueless, or detrimental to the cause. On the other hand, the national awakening to the necessity of providing adequate defense has been productive of measures and plans which, if carried through, would result in permanent assets to the country.

The conclusion seems to be warranted, that the major efforts in our preparedness program should be directed toward the improvement of industrial conditions. In the final analysis, war is a contest between the industries of the belligerents. Therefore, a country whose resources are exploited, whose industries and commerce are well developed, and whose systems of business, education and research have reached a high plane of efficiency would be incalculably better off in the case of a long exhausting war than if reliance had been placed on the military equipment alone.

Preparedness means, not only the optimum military and naval forces for repelling the initial onslaughts of the enemy, but also the power to quickly adapt one's self to the changing conditions brought about by war and to render available the latent resources in the shortest period of time.

It is the organization and development of these latent resources that should demand our attention at this time, as much as the preparation of war equipment for immediate use. This form of preparedness can not lead to militarism, for the results attained will be of as much value in time of peace as in time of war. Militarism is the great danger confronting our democracy at the present time, and war is its inevitable result.

To war the course of empire takes its way and the route is: *scaredness—preparedness—assuredness—war,* but a word to the wise is sufficient.

As a nation we are not sufficiently appreciative of the value to industry of research in pure science. In order to credit certain experimentation, we must see a well-established connection between the work in hand and the end sought. A clear and definite series of results pointing toward a certain conclusion must be produced before we are in a mood to consider the possible importance of the investigation.

Few of our manufacturers have realized the significance of a well-equipped research department in connection with their industries. This statement, however, does not apply to the testing laboratory, whose value has long been recognized and has its place in the factory. The expenditure of a certain percentage of the profits for launching investigations into unexplored fields is another matter.

Some of our manufacturers are still con-

tent to make their products like their grandfathers used to make them, as long as the industries pay a reasonable margin of profit.

The story is told of a large paint manufacturing company, where the superintendent had made repeated but unavailing recommendations to the board of directors for the establishment of a research laboratory in connection with the business. They could see no immediate returns accruing from such an expenditure, but finally yielded to the wishes of the superintendent and voted that a research chemist be employed not to exceed $75.00 per month, and that he be instructed to report to the head paint-mixer.

This attitude on the part of manufacturers has undergone a marked change and they are becoming more and more appreciative of the value in dollars and cents of scientific research. Whatever else may be the results of the European war, one thing is certain, and that is the inevitable stimulus to research in the industries. The influence that this division of science is having upon the progress of the war is exemplified on every hand.

A profounder testimony would be difficult to find than where the integrity of the Teutonic powers has been maintained for two years against a world at arms by the utilization of the results of one man's researches on the fixation of atmospheric nitrogen. Numerous other elements have, of course, contributed, but if nitric acid could not have been obtained in such enormous quantities, the war would probably have been at an end long before this. The latest developments of the Haber process will probably not be known outside of Germany until after the war, and it seems to me that this is one of the more important fields for research in this country at the present time. Why spend millions of dollars upon plants designed to employ an antiquated process, when it is known that other countries are now using a more efficient one? The temper of the American people is such that millions can be had for defense along known lines, but only a meager sum for research.

Almost every industry presents well-nigh infinite possibilities for improvement. The *ne plus ultra* of to-day will be scrapped tomorrow. What is required is an enterprising leader who dares to venture out into the woods on either side of the beaten path of factory routine.

The force of this statement becomes apparent the moment we awake from our lethargic sleep and begin to look about us. We find that the leaders in the industries are those who maintain research departments, for in that way they are able to keep ahead of their competitors by either supplying superior articles at equal cost or as good articles at less cost. Germany's dominating world industry in dye products has been built upon chemical research, its scientific instrument industry upon physical research. The perfume, drug and wine industries of France have been founded upon years of painstaking research.

Our own world industries of manufactured articles, such as photographic goods, oil and packing house products, machinery, steel products, electrical appliances, etc., all take root in research departments, and it is no chance coincidence that the industries supporting the most extensive research departments are those in the highest stages of development.

Now it is financially impossible for the vast majority of our industries to maintain research departments. They are as incapable of aiding their industries in this way as the individual farmers of the country would be in acquiring single handed the latest developments in agriculture as

worked out in the various agricultural experiment stations. Efficiency points to centralization and coordination.

The government has stepped in and aided the farmer where he was unable to get the results alone, but the government has not yet deemed it prudent to intervene in behalf of the small manufacturing industries so as to improve their products and put them on a higher plane of efficiency. This could be done by the establishment of a large government institution for chemical and physical research, with departments at least as numerous as the different industries to be aided.

Instead of the industries being helped by the government, they are actually hindered to a certain extent, especially in so far as unsatisfactory patent laws act prejudically against them. The vast majority of researches carried out in the universities are of such a nature that they have no bearing whatever upon present-day industries, and the essential results obtained in private research laboratories are kept secret so that the small manufacturer will ultimately be forced to the wall, unless he can surreptitiously acquire the processes of his wealthier rival.

Discovery is the aim of research even as it is the aim of all forms of experimentation. Discovery and invention may result upon the most superficial tests which in no sense could be classed as research. In fact, many important and far-reaching discoveries have been made as results of the crudest form of experimentation, but these are the singular exceptions. The rule is, that any important scientific or industrial advance has been made at the expense of years of experimentation and research along that line, coupled with the knowledge derived from countless other lines of work. One industry dovetails into another like the walls of a house and one science blends into another so that it is no longer possible to draw the dividing line.

Even as the sciences are developed by the contributions of thousands of workers, so each industry must depend for its advancement upon the labors and researches of a large number. What an enormous amount of research along many lines must have been carried out to bring the photographic industry to its present high plane of perfection! From the time that Scheele, Niépce and Daguerre made systematic studies of the actinic properties of silver salts, there has been an uninterrupted search for the hidden treasures in this field. The researches have extended into actinometry, organic and inorganic chemistry, colloid chemistry, electro chemistry, radioactivity, gelatine, glass, optics, heat, metal plating, mechanics, etc. No man is the discoverer or inventor of modern photography.

The men who do the pioneer work are usually railed at by the populace as impractical dreamers and scarcely ever live to see the full fruition of their labors. If Daguerre could have had a vision of the tremendous industry that has been reared upon the meager results of his research or if Clerk Maxwell and Hertz could have realized that their theoretical deductions furnished the basis for wireless correspondence across oceans, they could have met the attacks of their critics with a complacent smile. As an example of one man's contribution to industry, Pasteur is perhaps the most illustrious.

His thoroughgoing researches discovered the cause and pointed out the remedy for the souring and spoiling of beer, wine and fruit juices, and thus benefited France and other countries to the extent of millions of dollars. He also saved the French silk industry from certain destruction by the pébrine disease of the silkworm. He dis-

covered the cause and cure for rabies and anthrax, but greatest of all established the germ theory of disease and laid the foundation for serum therapy, an incalculable contribution to humanity. In commemoration of this notable work, his disciples will drink pasteurized milk for generations to come. Pasteur had his critics, too, even as formidable ones as the great German chemist Liebig who once wrote:

> As to the opinion which explains putrefaction of animal substances by the presence of microscopic germs, it may be compared to that of a child who would explain the rapidity of the Rhine current by attributing it to the violent movement of the numerous mill wheels of Mayence.

When the criticisms of thoroughgoing research come from the outside, they are not serious and vital, for time and subsequent work will establish the facts, but when criticisms come from the inside, from untrained officials in charge of the work, then it is they become serious.

What a mass of promising research work has been ruthlessly beheaded by conscientious superintendents, and directors in the name of "practical" results!

How can we distinguish between practical and theoretical research? What appears to the superintendent as being of no value whatever may have the germ of enormous practical returns in it, while the "practical" work he decides upon has such an immediate and superficial character that no appreciable gain, either for science or for the industry, will be made. This question of "practical research" is vital to the welfare of the American industries and should be given thoughtful consideration.

Neither science nor industry can make material advance until the basic laws and fundamental principles governing the same are understood, and the prime object of scientific research is to discover and verify these basic laws, while the purpose of a testing laboratory is to apply the laws already known to definite projects and industries.

What meager advance our electro-chemical industries could have made if it had not been for the discovery of the underlying principles by Faraday, Van't Hoff and Arrhenius.

Modern explosives owe their terribleness to the work of Sobrero, Pelouze, Eder, Schischkoff and Nobel. The soap industry is largely indebted to the painstaking researches of Chevreul; and the dye industry to Perkin, Hoffman, Fischer, Louth and Beyer.

Radium therapy was made possible by the discoveries of Mme. Curie and the multifarious applications of the X-ray rest upon the work of Crooks and Röntgen. The theoretical researches of De Vries and Pfeffer were of inestimable value to Burbank's plant-breeding experiments. Likewise, the "impractical" discoveries of certain rare gases in the atmosphere by Lord Rayleigh and Sir William Ramsay have now been made use of in the manufacture of the most powerful and economical incandescent lamps.

In this day and age no sane person would dare to say that a certain piece of fundamental research will be of no practical value for a hundred years to come. In a few years it might mean the cornerstone of an industry or a science.

At this time and in this connection, it might be well for us to ponder the words of the great French chemist, Dumas, when, in a speech delivered immediately after the close of the Franco-Prussian war, he said:

> The future belongs to science; woe to the nations who close their eyes to this fact. Let us call to our aid on this neutral and pacific ground of natural philosophy, where defeats cost neither blood nor tears, those hearts which are moved by their country's grandeur; it is by the exaltation of science that France will recover her prestige.

C. ALFRED JACOBSON

UNIVERSITY OF NEVADA

SCIENTIFIC NOTES AND NEWS

The fifty-third meeting of the American Chemical Society and the second National Exposition of Chemical Industries are being held in New York City this week. The address of the president, Dr. Charles H. Herty, of the University of North Carolina, was on "Expanding Relations of Chemistry in America." This address we hope to have the privilege of printing in Science, and the official abstracts of papers presented before the divisions of the society will, as usual, be printed here.

In the presence of Secretary Daniels and with appropriate ceremonies twenty members of the Civilian Navy Consulting Board, headed by Thomas A. Edison, took the oath of allegiance to the United States on September 19, as officers of the federal government. They were later entertained at a luncheon at the Army and Navy Club by Secretary Daniels. At the subsequent meeting the industrial survey of the country and the naval research laboratory were among the questions discussed. Those present besides Mr. Edison were Messrs. M. R. Hutchinson, W. R. Whitney, L. H. Baekeland, Frank J. Sprague, R. S. Woodward, Arthur G. Webster, A. M. Hunt, Spencer Miller, William Leroy Emmet, Matthew B. Sellers, Hudson Maxim, P. C. Hewitt, Thomas Robins, Howard E. Coffin, Andrew L. Riker, Elmer A. Sperry, W. L. Saunders, Lawrence Addicks and Bion J. Arnold.

The American Fisheries Society will hold its forty-sixth annual meeting in New Orleans, La., on October 16 to 19, inclusive. As this is the first meeting of the society to be held in any of the Gulf states, special consideration will be given to the problems and conditions of fisheries and fish culture in these states. Professor Jacob Reighard, of the University of Michigan, is president of the society.

Dr. Charles W. Pilgrim, superintendent of the Hudson River State Hospital, Poughkeepsie, N. Y., has been appointed by Governor Whitman to serve as president of the New York State Lunacy Board. Dr. James V. May, former head of the board, resigned some time ago to accept a similar position in the state of Massachusetts.

Dr. Alexander Johnson, for thirteen years secretary of the National Conference of Charities and Correction, has been selected as the expert for the Colorado State Survey Commission to investigate and make recommendations concerning the care of mental defectives and insane in the state, and the charities and corrections departments of the state.

Professor E. M. Lehnerts, of the department of geography of the University of Minnesota, has succeeded D. Lange as president of the Minnesota Forestry Association.

Dr. William H. Welch, of the Johns Hopkins University, sailed from England on September 20. Dr. Welch left for England five weeks ago to obtain data in connection with the organization of the Institute of Hygiene, which was made possible through a gift from the Rockefeller Foundation.

Dr. F. J. H. Merrill, from 1899 until 1904 state geologist of New York, has moved to Los Angeles, where he will resume consultant practise in geology and mining engineering.

For the academic year 1916–17, an exchange has been arranged between Professor Cassius J. Keyser, of the department of mathematics of Columbia University, and Professor Mellen W. Haskell, of the department of mathematics of the University of California.

Dr. M. C. Tanquary, assistant professor of entomology, Kansas State Agricultural College, who was granted a leave of absence in 1913 to accompany the Crocker Land Expedition, has returned to the Kansas Agricultural College and will continue his work in the college and experiment station.

Dr. Donald Reddick, professor of plant pathology, Cornell University, and chairman of the editorial board of *Phytopathology*, has been granted sabbatic leave and will spend the ensuing academic year in special work in the laboratory of plant physiology, Johns Hopkins University. Matters pertaining to *Phytopathology* should be addressed to him at Baltimore until June 1, 1917.

PROFESSOR H. MAXWELL LEFROY has been on special duty with the British army in Mesopotamia connected with fly investigations.

THE John B. Murphy Memorial Association has been incorporated in Illinois by Drs. William A. Evans, James E. Keefe, Allan B. Kanavel, Frank H. Martin and Frank Crozier. It is planned to raise half a million dollars for a memorial to the distinguished surgeon. The two requisites of the memorial are said to be that it be permanent and that it be a "living power making for the advancement of surgery on both the scientific and moral sides."

LEROY CLARK COOLEY, emeritus professor of physics in Vassar College, where he was head of the department from 1874 to 1907, died on September 20, at the age of eighty-three years.

JOSEPH HOEING KASTLE, director of the experiment station of the University of Kentucky, died in Lexington, Ky., on September 23, aged fifty-three years. Dr. Kastle became chief of the division of chemistry in the hygienic laboratory of the United States Health and Marine Service in 1905 and remained in that position until 1909, when he accepted a call as professor of chemistry at the University of Virginia.

SIR T. LAUDER BRUNTON, F.R.S., distinguished for his work in pharmacology and therapeutics, died September 16, at the age of seventy-two years.

DR. ENRIQUE NUNEZY PALOMINA, secretary of sanitation in the government of Cuba, and professor of medicine in the University of Havana, died in New York on September 15, aged forty-four years.

A. F. EMINSON has been killed in action while serving with the British army. Mr. Eminson had recently carried out some valuable investigations into the bionomics of *Glossina morsitans* in northern Rhodesia.

DR. W. ZURHELLEN, assistant at the Royal Observatory, Berlin, died on July 15, aged thirty-six years. It is noted in the *Observatory* that Dr. Zurhellen was one of the members of the Eclipse Expedition from the Berlin Observatory to the Crimea to observe the total eclipse of 1914, August 21. The last news which we had obtained of this expedition was that Zurhellen, being of military age, had been interned in Russia, whilst the older members of the expedition were allowed to return to Germany. After a year in Russia, Zurhellen was allowed to return to Germany; he joined the Bonn contingent, and was killed in the fighting in north France.

THE *Electrical World* quotes from an article in the *Electrician,* by F. G. Donnan, in which he urges a separate department of state to be called the "Ministry of Science." Some of the functions of this department are to establish national laboratories and "bureaus" for the purpose of undertaking extensive investigations; to guide the domestic and foreign policy of the cabinet by having ready at a moment's notice complete and detailed information concerning every question relating to science; to foster, endow and promote the teaching and investigation of science in the universities of the country by giving much larger grants of money to the scientific laboratories. The establishment of a great national bank is also suggested, whose special concern would be the fostering of new and old industries based on scientific method and scientific research.

THE United States Senate on August 29 ratified the treaty with Canada extending to all migratory birds the same protection on both sides of the Canadian border. The American Game Protective and Propagating Association, of which Mr. Edward F. Quarles is vice-president, drew up the provisions for that treaty, recommended them to congress and urged them in Canada. According to the New York *Sun* Mr. Quarles said that the regulations approved by the Canadian government provide for exactly the same degree of protection for migratory birds that is insured to them within the borders of the United States. By the act of congress, approved March 4, 1913, all migratory birds—wild geese, wild swans, wild ducks, snipe, woodcock, rail and all other migratory game and insectivorous birds—which, as the act reads, in their northern migrations pass through or do not remain per-

manently within the borders of any state or territory, shall be deemed to be within the custody and protection of the government of the United States and shall not be destroyed or taken contrary to regulations provided for by that government. The act which was passed in 1913 has been amended and the regulations drawn up by the Department of Agriculture for the enactment of the provisions went into final effect on August 21, 1916, when President Wilson publicly proclaimed the regulation. According to Mr. Quarles, the treaty will secure protection all over the North American continent for some 1,022 species and sub-species of birds, and the law is of prime importance to farmers, for it means that insectivorous birds will get the protection they deserve. All migratory birds, game and insectivorous, will be completely protected in the spring flights, during the breeding season, and the open season on the winter migration south will be curtailed in a great many species. The rulings as to open and closed season in each state have been made with due regard to the state's relative position in the great sweep of migration, north and south, and with provisions for the special protection of certain species in those localities where they have suffered under the old law, or where the farmer needs, for example, the presence of certain insectivorous birds.

The following series of Saturday afternoon lectures are being given in the Museum building of the New York Botanical Garden, at four o'clock:

September 2—"Plants of the Danish Islands, St. Croix, St. Thomas and St. John," by Dr. N. L. Britton.

September 9—"Across Mexico from Vera Cruz to Colima," by Dr. W. A. Murrill.

September 16—"Farming in the Middle West," by Dr. G. C. Fisher.

September 23—"Through the Mountains of Utah and Colorado," by Dr. F. W. Pennell.

September 30—"Flowers for Fall Planting," by G. V. Nash.

October 7—"Botanical Cruises in the Bahamas," by Dr. M. A. Howe.

October 14—"Destructive Fungi," by Dr. F. J. Seaver.

October 21—"Autumn Coloration," by Dr. A. B. Stout.

October 28—"The Potato Family," by Dr. H. H. Rusby.

November 4—"The New York Botanical Garden," by Dr. Britton.

November 11—"Planning Next Year's Flower Garden," by Mr. Nash.

The value of tar, ammonia and benzol products recovered in the manufacture of artificial gas in municipal plants and at by-product coke ovens in 1915 was nearly $25,000,000. Statistics recently compiled by C. E. Lesher, of the United States Geological Survey, Department of the Interior, show that more than 51,340,000 gallons of tar were obtained in connection with the manufacture of oil and water gas, that nearly 48,000,000 gallons of tar was recovered at coal-gas plants, 138,400,000 gallons of tar was obtained in connection with the manufacture of by-product coke, and that the total quantity of tar produced in the United States in 1915 was more than 237,400,000 gallons, valued at $6,260,000. The oil and water gas tar had an average value of 2.2 cents a gallon, the coal-gas tar a value of 2.03 cents a gallon and the by-product tar a value of 2.6 cents a gallon. Approximately 50,700 tons of ammonium sulphate was obtained from the coal-gas plants and about 197,000 tons from by-product coke plants, a total of about 198,000 tons. The value of this ammonia was more than $11,175,000. The coal-gas plants produced and sold 336,213 gallons of benzol, drip oil and holder oil, valued at $28,281, an average value of 8.4 cents a gallon. Benzol products recovered in connection with the manufacture of by-product coke amounted to 16,600,857 gallons, valued at $7,337,371, an average of 44.2 cents a gallon. It is thus seen that coal-gas plants are negligible as a source of supply of benzol products. Nearly 223,000 pounds of naphthalene, valued at $3,565, was obtained and sold from the coal-gas plants as compared with 465,865 pounds, valued at $46,959, from the by-product plants. More than 27,000 tons of retort carbon, valued at $183,170, an average of $6.73 a ton was obtained from the oil and water-gas plants and 1,696,366 tons of gas coke, valued at $7,222,744, or

an average of $4.25 a ton, was obtained and sold from the coal-gas plants in 1915. Including by-product, the output of which in 1915 was 14,072,895 tons, valued at $48,558,325, the coke and retort carbon produced in the United States was 15,796,461 tons, valued at $55,964,239. The value of the tar, ammonia, benzol products, naphthalene and coke produced in the United States in 1915 was $80,816,975.

The *Electrical World* notes that the great scarcity of potash has almost crippled many of the industries in this country, notable among others being the glass industry. The glass used in making incandescent electric lamp bulbs is a very special kind that must withstand sudden changes of temperature and also great pressure. Heretofore it has been thought that only glass made with a certain amount of potash was suitable for the lamp industry. The outbreak of the war two years ago cut off all supply of potash from Germany and threatened the supply of glass. The research chemists of the General Electric Company, however, succeeded in producing a glass for making incandescent electric lamp bulbs by replacing potash with soda in the glass mixture. This glass, it has been stated, has proved superior to the old potash glass; so much so, indeed, that from now on potash glass will no longer be used. The world supply of potash comes almost entirely from Stassfurt in Germany, because the natural deposits there have been cheaper to work than any other known source. The sources of supply in the United States have proved utterly inadequate to meet the great demand of the industries. Soda, on the other hand, is produced from ordinary table salt, great natural deposits of which are to be found in different parts of the country.

UNIVERSITY AND EDUCATIONAL NEWS

Dr. Thomas F. Holgate, professor of mathematics in Northwestern University and dean of the college of liberal arts, has been elected by the trustees *ad interim* president of the university, on the recommendation of the council of deans.

Dr. James R. Clemens has been elected dean of the John A. Creighton Medical College, Omaha.

Dr. A. I. Ringer, formerly assistant professor of physiological chemistry at the University of Pennsylvania, has been appointed professor of clinical medicine (diseases of metabolism) at the Fordham University School of Medicine, New York.

Dr. Leon F. Shackell, of Washington University, has been appointed an instructor in physiology at the University of Utah Medical School, Salt Lake City.

Donald W. Davis, Ph.D., of De Pauw University, has been appointed professor of biology in the College of William and Mary, and is succeeded at De Pauw University by Hardin R. Glascock.

At the State University of Iowa, George Bain Jenkins has been appointed professor of anatomy, and Vive Hall Young, assistant professor of botany.

DISCUSSION AND CORRESPONDENCE

THE SONG OF FOWLER'S TOAD (BUFO FOWLERI)

Various observers have described the voice of Fowler's toad. All descriptions indicate that only its characteristic, weird, droning scream has been heard.

Allen, speaking of the common toad in New Hampshire, believed that the toad's song changed from a prolonged trill to the weird note produced by Fowler's toad. He says:

> After the breeding season the toad's song changes from a prolonged pipe to a shorter, lower-toned note that, at night, has a peculiar wierdness and almost reaches a wail.[1]

Until recently the writer was convinced that Fowler's toad possessed but one song, the unmistakable, weird, wailing scream which advertises its presence throughout its range. It is now known that some individuals produce a

[1] Allen, Grover M., "Notes on the Reptiles and Amphibians of Intervale, New Hampshire," *Proc. of the Boston Soc. of Nat. Hist.*, Vol. 29, No. 3, 1899, p. 71.

prolonged trill resembling the characteristic song of the common toad.

While living at Clarendon, Va., near Vinson Station, the writer every spring has heard the steady, trilling monotone of a toad which he believed to be the common toad, *Bufo americanus*. These notes were among the first batrachian voices to be noted in springtime and were uttered more or less intermittently throughout the greater part of May. On May 2, 1916, the writer established the identity of the toad producing these trilling notes. Several[2] of these toads were captured in the filthy stream just north of Steele's Barn, near Vinson Station; others were captured in the stagnant pools along Fort Avenue, near Maple Street. These toads produced the steady, trilling monotone resembling the song of *Bufo americanus* as it is heard in New England. Although the trill of *Bufo americanus* sometimes continues for 30 seconds or longer, the trill of the toads captured near Vinson Station lasts only from 10 to 20 seconds. Although very variable in size, markings and general coloration, these toads are unquestionably Fowler's toads and can not be distinguished from individuals producing the typical, droning scream which lasts only for 2 to 3 seconds. Individuals producing these notes were captured at the same time and in the same localities.

The iris of both forms is bronze. Although Miller and Chapin[3] are of the opinion that the iris of *Bufo americanus* is bronze and the iris of *Bufo fowleri* is silvery in color, it is evident that such distinctions can not be relied upon in the diagnosis of the two toads.

It is hard to explain why some individuals of *Bufo fowleri* produce a steady, trilling note while others produce a brief, droning scream. These vocal differences, however, are in some manner correlated with fundamental differences of physiology and habit, since the trilling form is first to appear in spring and is rarely heard when the typical mating song of *Bufo fowleri* begins. In 1915, the brief, droning scream of *Bufo fowleri* was not heard at Clarendon, Va., until May 2. The trilling form is always heard early in April, several weeks before this period. After May 15 the trilling form is rarely heard, while the form with the brief, droning scream is heard until August.

The range of Fowler's toad has yet to be clearly established. The writer found this toad extremely common at Thompson's Mills, in northern Georgia. Whether or not this toad occurs in the Coastal Plain region of this state, or extends its range into the Gulf States, is not known. The westward distribution of Fowler's toad has also to be determined. Nothing definite is known concerning the relationship of this toad to *Bufo americanus* in the north, or to *Bufo lentiginosus* in the south.

H. A. Allard

Washington, D. C.

[2] These toads are now in the collection of the U. S. National Museum under accession number 59692.

[3] Miller, W. De W., and Chapin, James, "The Frogs of the Northeastern United States," Science, N. S., Vol. 32, No. 818, September 2, 1910.

BETTER COORDINATION OF UNDERGRADUATE COURSES

To the Editor of Science: A questionnaire recently circulated among alumni by the University of Minnesota (J. B. Johnson, dean), includes a call for suggestions as to the better preparation of students for public service. As the following proposal is not really limited to that application, but appears to be of a character to which the columns of Science have been open, I respectfully submit it for publication or other disposition as may to you seem fit:

Provide, in undergraduate courses and even at great expense, for "*laboratory*" *use* of that modern language elected by any group of students carrying at the same time (say) French or German and (say) physics, chemistry, animal biology, or history of European diplomacy.

When in college, the undersigned was not alone in wishing that the assistants in charge of laboratory hours would give their directions in, *e. g., French*—resorting to English only as might be rendered necessary by a student's failure otherwise to comprehend. The carrying out of this proposal would of course re-

quire that pamphlets of laboratory instructions be in general published in *three languages*, and it would appear that the most advantageous plan would be to use a *three-column page* —with a polyglot repetition of all material always before each student. This program (as to the absolute novelty of which no adequate investigation has been made) would at least soon enable the men to *use* one selected foreign language for scientific purposes, and it would at the same time invite a cursory acquaintance with another.

Those students taking, *e. g.*, French and physics, would, of course, on this basis, meet for laboratory work in physics separately from those taking German and physics; but the plan would seem worthy of trial even if it were found impracticable to hire as laboratory assistants in all the respective sciences mainly men capable of fluently speaking French or German. The plan could of course be introduced in an experimental way in connection with but one science and but one of the modern languages.

Bert Russell

Washington, D. C.

SYLVESTER AND CAYLEY

On page 484 of the third edition of Ball's "Short Account of the History of Mathematics" occurs the sentence:

> He [Sylvester] too was educated at Cambridge, and while there formed a life-long friendship with Cayley.

The two words "while there" seem inadvertently to have slipped in. Without them, Ball's sentence states two facts. With them, it seems capable of the paraphrase,

> Cayley and Sylvester were students at Cambridge at the same time and formed then a lifelong friendship.

Both of these statements are errors, and readily proved erroneous. Thus in the *Proceedings of the Royal Society*, May 9, 1898, page xii, we read:

> In 1831, at the age of seventeen, Sylvester was entered at St. John's College, Cambridge. He came out first in his first year.

In the same *Proceedings*, July 13, 1895, page ii, we read of Cayley:

> Accordingly, he went to Cambridge. He was entered at Trinity College on 2d May, 1838, as a pensioner, and began residence in the succeeding October at the unusually early age of seventeen.

He thus entered Cambridge at the same age as Sylvester, seventeen, but seven long years after him, and Sylvester had previously departed forever, never again to reside in Cambridge.

In the *Proceedings of the Royal Society*, Vol. LXIII., No. 393, page xii, we read of Sylvester:

> He pursued his studies till January, 1837, when he came out Second Wrangler. Being unwilling to sign the Thirty-nine Articles, he was unable to take a degree, to obtain a Fellowship, or to compete for one of the Smith's prizes. On the death of Dr. Ritchie in the same year he became a candidate for the Chair of Natural Philosophy in the London University College. He was appointed to the Chair at University College in the session 1837–38. He had some difficulty in drawing diagrams on the black-board to illustrate his lectures.

Sylvester left London for America to accept a professorship in the University of Virginia, but in 1844, when the foundations of the theory of invariants had been laid by Boole, Sylvester was back in London. For years he resided at 28 Lincoln's Inn Fields.

In the *Proceedings*, LVIII., No. 347, p. vi, we read of Cayley:

> He was unwilling to take holy orders. In consequence, it became necessary to choose some profession. Cayley selected the law, left Cambridge in 1846, entered at Lincoln's Inn.

And on page viii:

> It can hardly be that 2, Stone Court, proved an inspiration to mathematical research.

Thus separately thrown upon the rocky courts of the law, and by the same cause, the religious disbarments of Cambridge, the two were brought together. The biography in Sylvester's Collected Works feelingly refers to their fateful meeting. The ensuing union of their congenial and complementary minds endured without break.

Sylvester presented the first of Cayley's series of Royal Society Papers, and, inversely, Sylvester told me that if he wanted to know anything, he asked Cayley. In the *Proceed-*

ings, LVIII., No. 347, page viii, Forsyth says:

I have heard Cayley describe how Sylvester and he walked round the courts of Lincoln's Inn discussing the theory of invariants and covariants.

Sylvester told me that the only time he ever saw the placid Cayley beside himself was when in the midst of a discussion on the theory of forms a fat bundle of legal papers was brought in to him. Cayley dashed the plethoric bundle on the floor in an access of chagrin.

Thus London was the birthplace of this unique friendship, not the Cambridge which, before ever the gentle Cayley came, had sent out Sylvester without even a degree.

GEORGE BRUCE HALSTED

GREELEY, COLO.

SCIENTIFIC BOOKS

A Laboratory and Text-book of Embryology. By CHARLES W. PRENTISS, A.M., Ph.D., Professor of Microscopic Anatomy in the Northwestern University Medical School, Chicago. Octavo of 400 pages with 368 illustrations, many of them in colors. Philadelphia and London, W. B. Saunders Company.

In this new manual of embryology an effort has been made, as stated in the preface, "to combine brief descriptions of the vertebrate embryos which are studied in the laboratory with an account of human embryology adapted especially to the medical student."

The subject-matter of the book, following an introduction, is divided into twelve chapters. The introduction presents the scope of human embryology, emphasizes its importance to the medical student and includes a résumé of the history of the science and a brief statement of the principles of growth and differentiation of the embryo. After a discussion of the methods of study, in which the dissection of embryos as a class-room practise is strongly recommended, this section of the book is concluded by a short list of carefully selected titles of journals and other works of reference dealing with embryology. Chapter I. is devoted mainly to a review of those fundamental facts which are usually learned by the student in connection with the biological studies of his premedical preparation. The description of the human ovum, which is too brief, and the good account of the morphology and developmental cycle of the human spermatozoon should have formed part of one of the later chapters dealing specially with the human embryo. The reviews of the subjects of cell division, maturation, fertilization and the questions concerning heredity, sex determination and twinning may be amplified, if the student so desires, by consulting a number of original sources and well-known books, to which he is referred by citations in the text. In Chapter II. the topics of segmentation and the origin of the germ layers are treated from a comparative embryological standpoint, amphioxus, lizard, chick, bat and rabbit serving as representative types. The study of chick embryos is the subject of the third chapter. Here the text and figures are adapted to work in the laboratory. Directions are given for the preparation of specimens for study; descriptions of whole embryos and sections in three stages of development are presented. Descriptive embryology is resumed in Chapter IV., which discusses the subjects "fetal membranes and early human embryos." Here again the comparative method of exposition is employed with good effect. The main feature of Chapter V., which deals with the structure of small embryos of pig, is the full and careful description of the anatomy of the 10–12 mm. embryo as revealed by study of the surface form, dissections and sections. As this part is adapted primarily for use in the laboratory, the explanation given in the next chapter of the technical methods involved in the preparation of specimens, might better have been included in the present one. The technique of the dissection of embryos evolved in the Harvard Medical School for class practise is described in detail. In the same chapter (VI.) this method is advocated in the study of the face, palate, tongue, salivary glands and teeth. The remaining five chapters (VII.–XII.), comprising more than half of the book, are an account of the development of the organs and organic systems which the student may consult in connection with the more strictly laboratory work represented by

preceding chapters. The subject-matter is divided as follows: Chapter VII., entodermal canal; Chapter VIII., urogenital system; Chapter IX., vascular system; Chapter X., histogenesis, skin and muscles; Chapter XI., central nervous system; Chapter XII., peripheral nervous system. Ductless glands are described in Chapters VII., IX., XI.

It will be seen from this statement of the contents of the book that the subject-matter of embryology is broadly represented. The treatment of topics is in general proportioned to their importance in the understanding of embryology, as means for scientific training and practical application. Descriptions are in the main concise and clear. If we should classify the book on the basis of material used in the text and figures it would be a "mammalian embryology"; yet in order to meet the requirements of the medical student of to-day, examples of developmental processes from lower forms are necessarily brought forward. The directions for class-room dissection is a most commendable addition to a laboratory book on embryology since it will encourage the adoption of this valuable method. While the subject of histogenesis is extensively discussed in text-books of histology it has not had a conspicuous place in the works on embryology which are in common use among medical students; Prentiss's book is an exception to this case and the step taken in devoting a section to the phenomena of differentiation of cells and tissues will be appreciated. Another feature of this work for which the instructor will be grateful is the large number of references to original papers aptly dropped into the text. Incidentally, a review of the names referred to brings out the fact that American embryologists have taken no small part in contributing to the science of development. The book is amply illustrated by figures for the most part well chosen. Many original drawings are included, but the larger number comprises very properly figures taken from original papers. The color work, as a whole, is unusually good.

Mechanical errors are not as common as might be expected in a first edition: a few may be indicated. On page 87, "convexity" is printed evidently for "concavity"; at the bottom of page 234, "scroti" should be italicized to conform with the type of "septum"; the adjective for "tear" is spelled in some places "lachrymal," in others, "lacrymal." The presswork is excellent throughout and the choice of different type for the most part effective and in good taste. One exception might be pointed out: in the selection of type, the use of fine print in Chapter VI. in the description of sections gives the impression of secondary importance to this subject which is unfortunate. Whereas the attention to subjects is in general carefully proportioned, as already stated, there are some instances of inadequate treatment. The discussion of the spleen is too brief and the same is true regarding the origin of leucocytes. Almost nothing is to be found in the book concerning the development of the skeleton. Works on anatomy usually include accounts of the ossification but not of the early developmental processes. Surely a text-book of embryology should present the essential facts of the blastemal and chondrogenous stages of the skeleton. A chapter, or part of a chapter, might have been given over to a consideration of growth and postnatal development in order to emphasize the importance of these subjects which are represented by statements throughout the book in connection with the description of organs. Likewise the subject of histogenesis is not, from a pedagogical standpoint, presented with best effect coupled as it is in the same chapter with subjects quite foreign to it.

If we examine the author's method of treatment of the whole subject of embryology in presenting it to medical students, it is evident that his book fits the peculiar needs of the present time and to some degree points the ways in which the science is growing. Throughout, it inculcates the idea of the incompleteness of our knowledge of embryology and the need of working to gain fuller understanding of developmental phenomena. The text is descriptive of structure primarily, but also largely of the processes of development. More space could profitably have been given to phys-

iological aspects of organs. For example, the questions on the functions of the corpus luteum in the light of many researches, should have generous treatment in our text-books. The same can be said for the results of research in, and for theories on the mechanics of development, experimental embryology and of the field of heredity which is of highest interest to the physician. While these methods and new territories will receive more attention in the future, Prentiss's book probably deals sufficiently with them at this time.

R. J. T.

CONCERNING THE SPECIES AMŒBA PROTEUS

WHILE carrying on some experimental work during the past several years with the larger fresh-water amebas, I became convinced of the existence of considerable confusion concerning the description of *Amœba proteus*, generally regarded as the commonest species of the larger amebas occurring in our fresh waters.

In order to be sure of the exact nature of the organisms I was working on, which is of course essential in experimental work, I decided to look carefully into the matter of species description with the hope of removing, if possible, the confusion I was sure existed here. This work was completed some months ago, but on account of disturbances incident to the great war, the manuscript and drawings reporting the results of this work have apparently missed their intended destination—at any rate their present whereabouts are unknown. Since it is uncertain when the manuscript and drawings will be found again, I have thought that the publication at this time of a brief summary of my findings would be welcomed by other investigators of the larger amebas, who also must have felt the need of a reexamination of the specific characters of *A. proteus*.

Leidy in 1879 described in detail several species of amebas and to one of these species he applied the name *Amœba proteus*, resurrecting Pallas's (1766) old specific name which had been dropped through the influence of Ehrenberg. Leidy described the nucleus of *proteus* as "a thick *discoid* body, with the broad surfaces somewhat convex, flat, or slightly depressed, and the border rounded."[1] Most of his figures show the nucleus a concave discoid.

Penard described *Amœba proteus* as possessing "always an *ovoidal* nucleus."[2]

Now a discoid differs fundamentally from an ovoid. A discoid is a solid generated by revolving a semi-ellipse around its short diameter as an axis, while an ovoid is a solid generated by revolving a semi-ellipse around its long diameter.

Penard's *proteus* is not at all the same species as Leidy's *proteus*.

The question therefore is, Is Leidy's description adequate? It is adequate. All his figures show discoid nuclei, as may be seen by inspection or by reading the descriptions, with one possible exception, perhaps two: Figs. 3 and 4, Plate II. In these two figures the round or polar view of the nuclei is shown. Although these two figures resemble Penard's *proteus* more closely than they resemble Leidy's typical *proteus*, there is not sufficient evidence to enable one to be quite sure of their correct species reference. There can be no question then but that Leidy considered the *proteus* to have typically a discoid nucleus.

Penard described an *A. nitida* with a much folded or crushed-in nucleus and says[3] that Leidy's drawing of the *proteus* nucleus (Fig. 9, Plate II.) "represents so characteristically" the folded nucleus of his *nitida*. But Penard misinterpreted Leidy's figure entirely. Leidy's figure does not show a folded nucleus, but one with a smooth surface, a discoid with slightly concave sides. Moreover, the folded nucleus of Penard's *nitida* I have found represents an old-age stage of the smooth discoid nucleus of Leidy's *proteus*. The ectoplasmic ridges and grooves described by Penard as canals in the endoplasm of *nitida* were also observed by Leidy in *proteus*. Penard's *nitida* represents therefore old (or abnormally large) individ-

1 "Rhizopods of North America," 1879, p. 41.

2 "Faune Rhizopodique," 1902, p. 58.

3 *Loc. cit.*, p. 61.

uals of Leidy's *proteus,* or probably a varietal strain of this species in which the nucleus readily becomes folded. (Penard does not discuss anywhere to my knowledge the fact that Leidy speaks repeatedly of a discoid nucleus in *A. proteus.*)

According to the rules of priority of the International Code, therefore, Leidy's (really Pallas's) name *proteus* must stand for the ameba possessing a discoid nucleus and longitudinal ectoplasmic ridges and grooves on the pseudopods. This leaves Penard's *proteus*—the ameba with an ovoid nucleus—without a name, the name *proteus* having been preempted by Pallas and Leidy. I therefore propose the name *dubia* for this species.

This then clears up the confusion arising out of observations and descriptions relating to *A. proteus* as recorded by Leidy and Penard; but in the progress of my work in this connection some new observations were made which may properly be incorporated in this summary.

To wit: I found that the species *proteus* as Leidy described it may be divided into two species, one of which is larger than the other and always exhibits more or less conspicuous longitudinal ridges and grooves on the pseudopods and frequently shows folds on the nucleus; while the other and smaller species never shows ridges or grooves on the pseudopods nor is the nucleus ever folded. From Leidy's figures and descriptions it is evident that the former species—the one showing ridges and grooves—was considered by him the typical *proteus,* and this name should therefore be retained for this ameba according to the code. For the other species I propose the name *discoides.*

Amœba proteus then is recognized readily by the presence of longitudinal ridges and grooves on the pseudopods. *A. dubia* is easily recognized by the possession of an ovoid nucleus. *A. discoides* is recognized by a discoid nucleus and the absence of folds and grooves on the pseudopods. Any ameba in normal condition belonging to either of these three species may be readily recognized in the living condition under 360 diameters' magnification, according to the characters here enumerated. Of these three species *proteus* and *dubia* are the larger and the more common, while *discoides* is somewhat smaller and less common, so far as my experience goes.

These findings are based on individual pedigrees running for upwards of a hundred generations each for *proteus* and *dubia* and for about forty generations of *discoides,* including always a number of collateral lines. Numerous individuals from wild cultures from various localities were examined and compared with the pedigreed stock. There is much greater permanency in the so-called protoplasmic characters than is commonly realized.

This is a brief and doubtless somewhat unsatisfactory summary of the work on these amebas, but for fuller details and drawings reference must be made to the original paper, which I hope may soon be found and published.

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ZUÑI INOCULATIVE MAGIC

THERE are many varieties of sympathetic magic at Zuñi. I shall give only instances of that subdivision of the homeopathic variety which may be called magical inoculation. It is a form, as it were, of discharming. Instead of applying a bit of the analogous thing to produce an analogy, the direct form of homeopathy, a bit is applied to overcome the analogy, the principle obviously of inoculation.

Birthmarks and malformations are accounted for by the Zuñi as due to parental, for the most part paternal, carelessness during the pregnancy, the result of the expectant father taking part in a ceremonial or hunting rabbits or prairie dogs of other animals or killing a snake. The child will be marked in some way like the ceremonial mask or spotted like a snake or according to the injury suffered by the quarry, blinded or maimed. A medicine member of the Ne'wekwe or Galaxy Fraternity told me that at birth the forehead and chest of his son had had the print of an entrail—preoccupation with the entrails of animals is a characteristic of the Ne'wekwe Fraternity, and this man had in fact taken part in a fra-

ternity ceremonial before the birth of his son. The head of the daughter of this once birthmarked man was a bit flattened on one side. It was flattened, believed her grandfather, because her father would go prairie-dog hunting before her birth and he always shot his prairie-dogs in the head.

Now the cures for birthmarks or malformations are, the cause being a ceremonial, to put on the ceremonial mask in question and dance hard in the presence of the child, subsequently rubbing the sweat of one's body on to the child; and, the cause being a hunted animal, to hunt the same animal and rub its blood on the child. Similarly, to cure an infant of crying incessantly—it cries because its back pains and its back pains because before its birth its father has overdriven his horses, belaying them presumably on the back—to cure it one must drive a team hard and rub on to the child's back the sweat from under their collar or some piece of their harness.

If a child becomes deaf—cases of deafness at birth are unknown—it is because during her pregnancy its mother stole. To cure the child she must steal again and burning the object stolen puts its ashes into the ears of the child. If the cord of a new-born infant "runs," it is because one who has been bitten by a snake has been present in the room. That person should be found and then four times he should wave some ashes around the heads of mother and child. Otherwise the child will die.

The deer-hunter who sees a buck and doe together and the buck mount the doe, knows that by this token the deer are "telling" him of what is happening at home. His faithless wife is far from "staying still" in the house she should leave but once, at noon time, for water, while her husband is off hunting. It becomes his business, therefore, to shoot the deer and take out their hearts. On his return home he will find his wife and her lover sick. To cure them, if he pity them, he will have to rub them with deer heart made up into a ball with meal, rubbing the woman with the heart of the doe, the man with the heart of the buck.

Should a person be struck or shocked by lightning, he or she must be given some rain water of that same storm to drink, rain water plus black beetle and suet. Otherwise the person will "dry up" and die.[1] About three years ago a certain house on the south side of the river was struck. The three women in it neglected to take the prescribed drink. To-day the three are dead, two dying a year or two ago, the third this summer.

Should a person in dying "frighten" any one, from the head of his corpse a lock of hair is cut. The hair is burned and the smoke of it is inhaled by the person who has been upset. This practise, however, is uncommon.[2]

ELSIE CLEWS PARSONS

SPECIAL ARTICLES

THE IMPORTANCE OF LATERAL VISION IN ITS RELATION TO ORIENTATION

It is a well-established principle that binocular vision gives to human beings a means of determining the relative distances between near-by objects, as well as the distances of these objects from the observer. The basis of this power lies in seeing the objects from two points of view, giving a stereoscopic effect, which, however, is decreasingly effective as the objects are removed from the eyes. It is apparently partly the decreasing stereoscopic effect with increasing distance which forms the basis of measurement; and partly a judgment of distance in some way through the muscular movements of the eyes, and those governing the accommodation of the lenses. The power of measuring distance by binocular vision is, however, scarcely effective at distances greater than four or five hundred feet. It is entirely

[1] The experience qualifies a survivor for becoming a doctor. One of the present *tenientes* or members of the governor's staff or council is a lightning-struck doctor.

[2] Mrs. Stevenson's description of this practise is somewhat different, remaining, however, one may infer, an illustrative of inoculation magic. "If a person takes a bit of hair of a deceased friend, burns it, and inhales the smoke he will have good health and not die, but go to sleep and thus pass on to Ko'thluwa'la" ("The Zuñi Indians," p. 309, XXIII. (1901–02), *Am. Rep. Bur. Amer. Ethnol.*).

lacking beyond fourteen hundred feet, according to Gleichen.[1]

In the case of a man moving through a forest or any maze-like region, owing to the frontal position of his eyes, the axis of his vision is parallel to his motion; hence the apparent displacement of the trees of the forest as seen by him, due to his forward motion, is a *minimum*. The effect is similar to that when a person is riding on a railway and looking out from a front window of a car straight at the track and its immediate surroundings. It is obvious that relative displacement of objects near the track in the retinal picture due to motion of the observer is very slight. In frontal vision, as in man, a displacement of the head *sidewise* affords a powerful means of measurement of distance, as has been pointed out, probably first by Helmholtz.

The eyes of most birds, fish and reptiles are so situated in the skull that only lateral vision is possible. A number of species of birds, however, have the ability to turn the eyes so as to give binocular vision at will, and some species have two distinct vision foveæ, "yellow spots," in each eye, for distinct sight for the two types of vision. Other species have two of the round and one streak-like foveæ; particularly certain ground-feeding birds of the snipe family, etc.[2] Some of the mammalia have lateral vision, some have their eyes so placed that the retinal pictures partially overlap and binocular vision is possible; others have frontal vision as in man. It is interesting to consider in what manner the lateral position of the organs of vision enters into the determination, for example, by a bird, of the distances of surrounding objects. It is an important question, owing to the intimate connection of such determinations with the "sense of direction" problem.

There seems to be good evidence that those living creatures having side vision have a decided advantage over man in their ability to gauge or measure the relative distances of their surroundings, owing to the lateral position of the eyes. When a bird or a mammal, etc., with its eyes so placed, moves forward, the principal visual axis is *perpendicular to its motion*. This gives the *maximum* apparent displacement of objects with every forward motion of the creature.

This displacement of surrounding objects gives to the animal having lateral vision a means of a continual register of the *relative distances apart* of surrounding objects. To use the analogy of a person riding on a railway, it is as if one was looking out of a side window of a car. There is the additional advantage for the animal, since it may be said to be looking out of two side windows, one on each side. There is, moreover, the possibility, in the case of creatures having lateral vision, of a differential effect, since a change in the direction of the head while in the forward motion would be registered on the retina of each eye. The advantages of lateral vision for measuring the relative distance of surrounding objects is illustrated as follows:

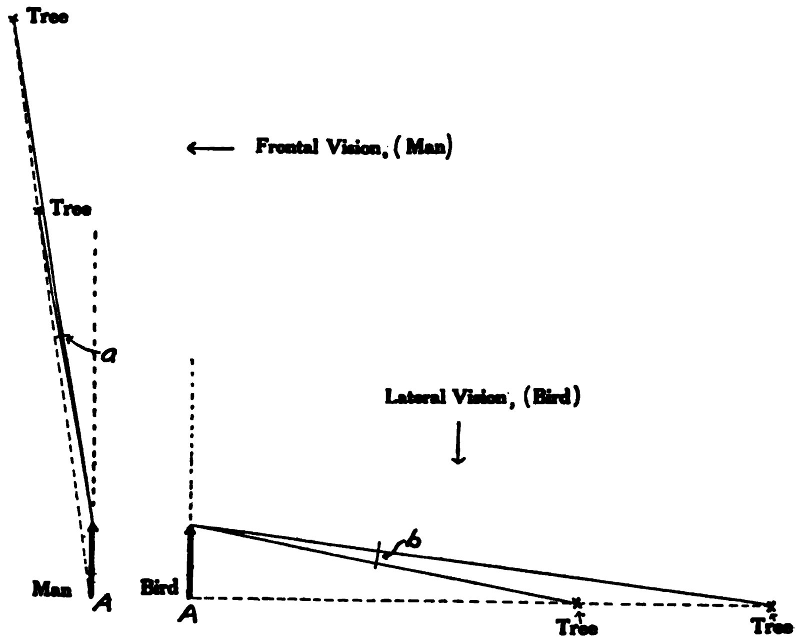
The arrows in Figs. 1 and 2 are meant to represent a man moving forward along a straight path 15 feet, and a bird also moving forward 15 feet respectively. Both observe trees (the crosses) at 100 feet distance from *A*, the starting-point.

The trees are in front, nearly, of the man in the one case, and at the side of the bird in the other. The angles *a* and *b* are the angular measures of apparent displacements in the two cases, due to the forward movements. With the distances given in Figs. 1 and 2, these angular measurements are as 5 is to 1 in favor of the bird, but this is assuming that the man has only one eye. For distances within a few hundred feet of the man, as in Figs. 1 and 2, binocular vision is a means of measurement of distances, and hence the bird's advantage is less than the ratio given. It is, in fact, hardly possible to state a true measure of the advantage.

In Fig. 1 it is necessary to place the trees considerably to one side of the man's path; otherwise there would be no angular displacement of the trees for the man whatever.

[1] A. Gleichen, "Die Theorie der Modernen Optischen Instrumente," p. 184.

[2] "Lehrbuch der Vergleichenden mikroskopischen Anatomie," Part 7, pp. 82–84.



FIGS. 1 and 2. These diagrams show the parallax (displacement) of objects as viewed in frontal vision and in lateral vision. The ratio of b to a, with distances given in the text, is 5 to 1.

In order to give figures showing the advantage of lateral vision over frontal vision at greater distances due to motions forward, two cases were selected where the objects are two trees, one at 1,000 feet and the other 2,000 feet distant, respectively, from the observer (man and bird), the trees being approximately in the axis of vision in each case. To obtain any values it is necessary (as in Fig. 1) to place the two objects observed (trees) out of line of the direction of the man's motion; that is, to one side of his path. The results in Fig. 3 and Fig. 4 were obtained from a graphical construction which is omitted.

Fig. 3 is an equal parallax curve and it shows the distance that a man and bird must each move forward to give the same apparent displacement of trees against the horizon. In the figure the points are plotted as they were found from the graphical construction, and show a slight irregularity.

Fig. 4 is a curve constructed from Fig. 3, and it illustrates the decided advantage of the bird over the man.

The bird's advantage is obtained by dividing the distance that the man must move forward by the distance that the bird moves forward to obtain *equal displacement of the objects viewed*. For example, at the point *M*, the man has moved forward 20 feet and the bird's advantage is 12 to 1. At point *N* the man has moved forty feet, and the bird's advantage is 10 to 1, etc.

The distances of one thousand and two thousand feet were taken as a basis for the curves in Figs. 3 and 4 because binocular vision is not a means of measurement at these distances, and hence the advantages for the bird are as they have been given in the figures.

This method of demonstrating the advantage of lateral vision serves chiefly to give some numerical expression of the value of that type of vision for the measurement of the distances apart of objects in the field of view.

In conclusion it may be stated then that an animal having only lateral vision, *if at rest*, has no means of measuring the relative distance of surrounding objects, except by comparison of the various size of objects, and

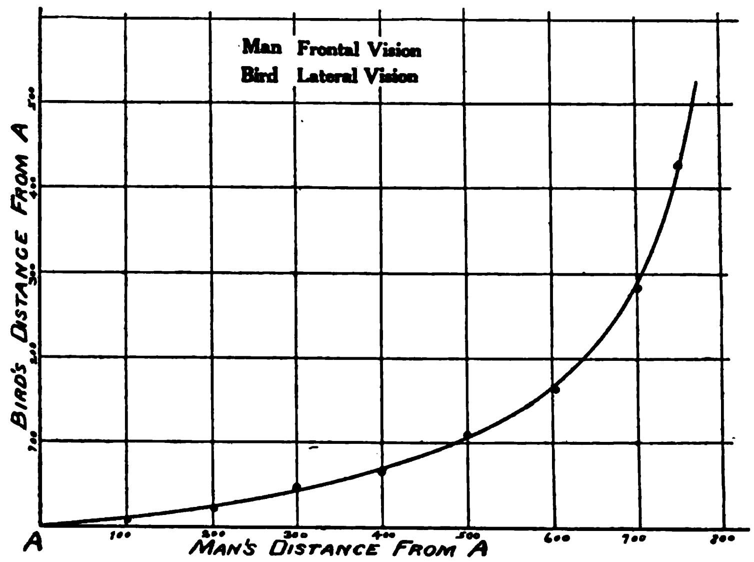


FIG. 3. Equal parallax curve, showing the distances a man and a bird must move forward to give the same apparent displacement of objects against the horizon.

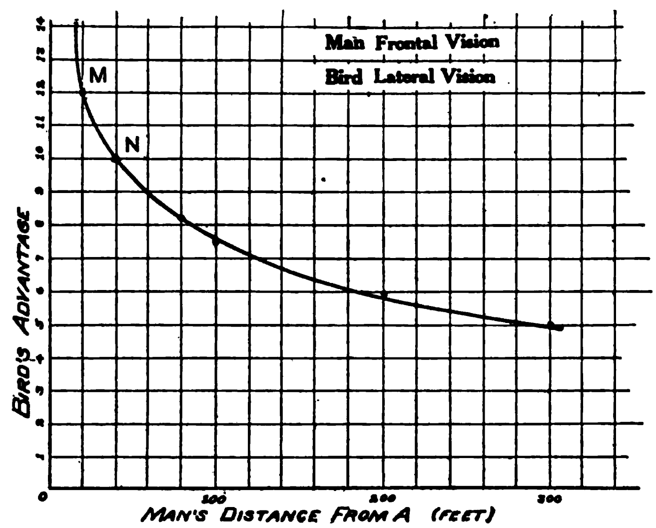


FIG. 4. Advantage curve. The bird's advantage is obtained by dividing the distance that the man must move forward by the distance that the bird moves forward to obtain the same displacement of objects viewed. At *M*, the advantage is 12 to 1; at *N*, 10 to 1, etc.

through accommodation, etc. An animal having binocular vision (man, ape, cat, etc.), *if at rest,* has such a means for the measurement of objects that are not more than a few hundred feet distant.

If creatures having each type of vision are *moving forward,* then there is a distinct advantage in favor of the one having lateral vision. This is especially the case if the objects viewed are in the middle ground (500 to 1,500 feet away), or at greater distances, since binocular vision furnishes little, if any, means

for measuring the relative position of objects at these distances. Thus an animal with lateral vision, when moving forward, has a stereoscopic view of the landscape, owing to the excessive relative displacement of objects. A person looking out of a side window of a moving railway car sees the landscape in the same way.

This power of measuring surrounding distances due to lateral vision is important in its bearing on the "sense of direction" problem because the orientation of a bird with respect to *points of reference about it* depends on the subconscious summing up of the space relations immediately about the bird as it moves here and there through the woods or through any familiar or unfamiliar region. This subconscious summation on the part of the bird is greatly aided by any means which measures the relative distances of minor reference points in its immediate vicinity as it passes on its way.

The writer is not aware that the power that animals having lateral vision seem to possess of measuring the distances in their surroundings has been pointed out hitherto. That there is such advantage over frontal vision, as in man, appears to be evident. In any case, the relation of lateral vision to near-by orientation has not been properly emphasized. This short paper is a part of an investigation on "sense of direction" in animals, which has been aided by the Herman Fund of the New York Academy of Sciences. C. C. Trowbridge

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THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE—SECTION B, PHYSICS

The biggest and the best of the several meetings the American Physical Society holds every year is always that one held jointly with Section B of the American Association for the Advancement of Science. There are of course very few active members of this section who are not also active members of the Physical Society and therefore it might seem that there could be no advantage in holding joint meetings. Indeed it might even be argued that the Physical Society had better meet at some other place where there were none but physicists—no distracting reminders of other sciences and other interests.

But, as just stated, the uniform experience is strongly in favor of the joint meetings. And one thing that makes the annual meeting so delightful and so profitable is the frequent, even if more or less casual, conversations with scientists whose chief interests are in other subjects—delightful because of the charming acquaintances formed and profitable because of the new interrelations one is quite certain to see between his own and other sciences.

The recent meeting at Columbus, Ohio, at which President R. A. Millikan, of the Physical Society and Vice-president E. P. Lewis, of the American Association for the Advancement of Science, alternately presided, was one of these pleasant and profitable occasions.

The address of the retiring vice-president of the association and chairman of Section B, Dr. Anthony Zeleny, was a well-deserved tribute to the designer and the maker of instruments of precision upon whom advancement in science so greatly depends. It appeared in full in Science for February 11.

The symposium—always a delightful feature of these joint meetings—was on the behavior of substances at very high pressures. Dr. P. W. Bridgman gave a most interesting summary of the numerous discoveries he has made of the properties of substances at enormously heavy pressures—properties stranger than fiction and of great importance.

At present the officers of Section B are as follows:

Vice-president and Chairman of the Section: H. A. Bumstead, Yale University.

Secretary: W. J. Humphreys, Washington, D. C.

Member of Council: A. L. Foley, University of Indiana.

Sectional Committee: Vice-president, San Francisco and Columbus, E. P. Lewis; Vice-president, New York, H. A. Bumstead; Secretary, W. J. Humphreys; Preceding Secretary, Alfred D. Cole; T. C. Mendenhall, one year; Dayton C. Miller, two years; George W. Stewart, three years; Robert R. Tatnall, four years; W. S. Franklin, five years. *Ex-officio:* R. A. Millikan, President, American Physical Society; Alfred D. Cole, Secretary, American Physical Society.

Member of General Committee: G. B. Pegram, Columbia University.

W. J. Humphreys,
Secretary

SCIENCE

FRIDAY, OCTOBER 6, 1916

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-On-Hudson, N. Y.

THE EXPANDING RELATIONS OF CHEMISTRY IN AMERICA[1]

AFTER a year of such strenuous service as characterized that through which we have just passed, it is well that we are again assembled for report on the work of our laboratories and for helpful conference concerning future growth and broader service. A large part of the past year's work has, through the suddenness of the call, been necessarily individualistic; the assemblage of this week furnishes the means for planning more coordinated effort for mutual counsel and for deepening that spirit of cooperation which is so essential if we are to worthily meet our full responsibilities.

It is again incumbent upon me to address you. In seeking a subject I have put aside the temptation to lay before you statistics illustrative of marvelous growth during the past year, and, in spite of our belief in specialization, it has not seemed suitable to select any one line of development for tracing in thorough detail. This period is still too formative and the demands upon you too many-sided for such restricted discussion. I have therefore selected the broader topic "The Expanding Relations of Chemistry in America," using the present participle advisedly as indicative of growth and as mandatory of greater effort if the widening circles of chemical influence are to reach the broad shores of full-fledged accomplishment.

The dynamic center of this movement is

[1] Address of the President of the American Chemical Society read at the New York meeting, September 26, 1916.

the American Chemical Society, which now consists of 8,136 members, a net growth of more than one thousand during the year just ended. This splendid growth is not only a tribute to the energetic activities of our efficient secretary, but is an evidence of increased activity in chemistry and of a quickened realization of the need of the strongest possible national organization. The strength of this organization, however, is not measured so much by numbers as by the loyal and unselfish response of its members to every call made in its name. To this I can abundantly testify.

In considering the expanding relations of chemistry in America let me group these under four heads—the relations to university administrations, to the national government, to our daily needs and to national thought.

RELATIONS TO UNIVERSITY ADMINISTRATIONS

Without doubt university executives have gained during the past year a clearer conception of the fundamental value of chemistry to the nation. Aside from our own exhortations, this conception has been easy of obtainment through the increased publicity given by the daily press and by periodicals to matters chemical, through the difficulty of purchase of certain needed supplies, through the feverish activity to meet these unexpected demands, and through the call for young chemists from university laboratories. Has the conception, however, been translated by the makers of university budgets into deeds which will insure an adequate response by the universities to the increased demand which is to be made upon them for chemists possessed of the best possible training? I have neither purpose nor desire to criticize, nor even to attempt answer, but I do not hesitate to suggest that in these abnormal times the demands upon chemistry departments are unusually great and should be generously met if we are to view the future with equanimity. The bounds of the service of chemistry to the nation are prescribed by the character and extent of the training given in our universities. Physical equipment must be increased and bettered, and staffs must be maintained adequate in number to allow full opportunity for research along with teaching duties.

The stimulus of these remarkable times upon the minds of the students is plainly evident, but here lies a danger. The expansion of existing industrial plants and the creation of new lines of endeavor in chemical industry call for many young men to serve in control work, and the call is often very alluring. It would be a great misfortune if the filling of these new positions should be at the expense of the graduate students of the future. We can not afford an abridgment of the number of young men thoroughly trained in our universities in the methods of research. Graduate fellowships in largely increased number should be provided, for without such aid the door of opportunity will be closed to many whose full mental potentialities will be needed in the future.

The danger of losses from university ranks, however, is not confined to graduate students: already there are strong indications of a considerable raid by the industries upon the staffs of universities, and the question of professorial emolument is therefore not one for leisurely future consideration, but belongs to the immediate present.

To sum up the university budget for chemistry needs prompt and decided expansion.

In the matter of cooperation between universities and industries definite progress has been made. Four important matters typify this progress.

The New York Section has conducted

throughout its winter meetings a symposium on this subject, and these discussions resulted in a request of the society that a permanent committee be appointed to carry forward vigorously such cooperation.

The General Chemical Company announced the formulation of a new policy in the creation of an advisory staff of university professors.

The Massachusetts Institute of Technology announced a master's course in chemical engineering, including a school of chemical engineering practise. Through the cooperation of industrial plants a half year of systematic plant experience and training is added to the curriculum without sacrifice of thorough foundation work or training in research. In return for the privileges offered by the plants, the research facilities and the faculty of the institute will be available for the study of special problems connected with each plant.

A joint meeting of the Puget Sound Section and the Seattle Chamber of Commerce aroused great enthusiasm and resulted immediately in the creation of industrial fellowships in the University of Washington for the study of the problems of the northwest.

Such illustrations furnish proof that earnest thought is being given to this phase of cooperation and it is inspiring to note how quickly such thoughts are being translated into definite action.

RELATIONS TO THE NATIONAL GOVERNMENT

Forty-nine members of the society, representing the several states and Alaska, on appointment, responded to the request of the President of the United States that the chemical industries be mobilized under the program of the organization for industrial preparedness. Publication of the correspondence in connection with these appointments would furnish lasting testimony to the loyal and unselfish patriotism of the membership of our organization.

In response to the invitation of the National Academy of Sciences our representatives are now cooperating in the organization of the research facilities of the nation and in questions connected with the establishment of the government nitrate plant.

If we are to promptly and intelligently proceed with the development of a diversified and comprehensive chemical industry we must know the detailed character and amounts of chemical importations. The statistics now published by the government are inadequate in their itemization. The formulation of the character of the information needed is our responsibility. This is the work of the committee on government statistics, of which committee Dr. B. C. Hesse is chairman. The inauguration of the work has unfortunately but necessarily been delayed. It is now well under way, and for its full consummation I beg to urge the thoughtful aid of every member of the society, and the cooperation of each of the local sections. We have never undertaken any more important or fundamental work than this. If, as a result of this inventory, we are able to state in exact terms the specific character of the information needed by the chemical industries, in order to render this country independent of foreign sources of supply, we will then have a right to expect with confidence the sympathetic cooperation of the federal authorities.

May I, under this heading, make two suggestions to the national authorities:

First, Provision should be made in the immediate future for the storage of large quantities of government-owned toluene. With the cessation of European war orders for explosives, and with the rapid increase of by-product retort ovens for coke manufacture we will eventually have a large over-production of toluene, with conse-

quent lowering of price. The potential value of this hydrocarbon in munitions is too great to allow its sacrifice as a fuel or as an illuminant, and its storage involves no unusual difficulties. The moral effect alone of its known presence in our midst would in itself justify the investment as a preparedness measure.

Second, Modern warfare is largely dependent upon the successful work of chemists, not alone in the direct production of munitions, but, through research, in husbanding the resources of the country, and in increasing knowledge which in times of stress may be vital to the nation. In view of the now well recognized fundamental character of such work the military authorities should formulate a definite policy in regard to the chemist, whereby in times of war his services may best be applied to the advantage of his country. The lack of such a policy during the recent enlistment of the National Guard has in several cases interrupted lines of research whose successful outcome would prove much more vital to the power of the army than the presence of the individuals bearing arms. England somewhat tardily recognized that her chemists were more needed at home than at the front and therefore recalled them.

RELATIONS TO OUR DAILY NEEDS

The economic developments of the past two years have emphasized the close relation between normal daily needs and the activity of chemists, particularly through certain shortages which have brought economic distress. Among these shortages three stand out preeminent—motor fuel, potash for fertilizer and coal tar products, particularly synthetic dye-stuffs. Let me discuss the first and second of these briefly and the third somewhat more at length.

Motor Fuel.—The enormous annual increase of motors using gasoline as fuel, together with the largely increased export of this material, has resulted in greatly increased price of this product. To meet the situation chemists have naturally turned their attention to the "cracking" of the residues of crude petroleum, furnishing thus some relief. In view, however, of the uncertainty of petroleum supply such efforts can not prove the ultimate solution of the problem. With the cessation of the war further aid may be expected from the benzol recovered in the by-product coke oven plants. With this at its maximum, however, it is estimated that it would equal only ten per cent. of the motor fuel now consumed. Plainly we must look further for the permanent supply, and that seems to me to be alcohol. I am fully aware that there is nothing original in this suggestion. It is mentioned rather for the purpose of urging greater consideration of the problem by chemists, who must solve the problem, by manufacturers of motors who have such great interests at stake, and by lumbermen who, in their mill waste alone, possess the raw material from which, by processes in operation to-day, alcohol could be produced equal in volume to forty per cent. of our present gasoline consumption.

What striking advance in this line could be confidently expected if the automobile manufacturers and lumbermen of the nation would join forces with chemists in the creation of a great research laboratory where the problems of motor fuel could be vigorously attacked, not by the "green powder" method of recent notoriety, but by common sense, scientific investigation, conducted by the ablest of chemists and chemical engineers, unfettered by tradition and filled with the conviction that the day of genuine new things will never end.

Potash.—To meet our present shortage of this valuable fertilizer constituent we

have sought relief feverishly through the kelp fields of the Pacific coast, the alunite deposits of Utah, the feldspars, blast furnace and cement works waste, and have as yet obtained but slight relief. Something noteworthy may yet result from these earnest efforts, especially through the aid of the appropriation of $175,000 by congress for further investigation of kelp, but at present we seem to have adopted the general policy of waiting until the war is ended.

Let me, in this connection, remind you of the old problem, namely, the rendering available *in situ* the potash now in the fields in the form of silicates. The records of the U. S. Bureau of Soils show that the average weight of a foot acre of the sandy soil of the cotton belt is 1,750 tons, and it contains an average of .1 of 1 per cent. potash, or $1\frac{3}{4}$ tons K_2O per acre, while the clay soils average in weight 2,000 tons per foot acre, and show an average potash content of 1.68 per cent. or 33.6 tons K_2O per acre. From this material nature slowly supplies available potash for plant food through the action of the soil solution upon the potash-bearing silicates, but the process is too slow. Many lines of research are in daily progress in our laboratories whose object is the discovery of "accelerants" for certain chemical reactions. Does not the importance of this problem and its altogether normal character demand of us greater effort to find a suitable accelerant for this world wide process. The problem is easy to state, its solution has as yet proved impracticable. May we not hope that the activities of physical chemists through studies of the soil solution and its action upon the mineral constituents of the soil will ultimately be successful?

Coal Tar Dyestuffs.—It is unnecessary for me to remind you at this time of the great disturbance of our industrial life which resulted from the cessation of imports of German dyestuffs, nor of the rapid extension of the by-product coke oven whereby we are now assured of a far more than adequate supply of raw material for an American dyestuff industry sufficient for American needs. It is a pleasure to testify to the energy and resourcefulness of our dyestuff manufacturers who, in spite of competition with the munitions industry for coal tar crudes and for necessary acids and with uncertainty as to the future constantly dogging their steps, nevertheless, have notably contributed to the relief of the dyestuff famine.

It is my purpose, however, to trace, for the sake of the record, the efforts made during the past two years to obtain legislative assurance of a fair start in the upbuilding of a well-rounded permanent industry, and to point out the character of the legislation which on the last day of the present session of congress became a law of the land. It is a distressing story, humiliating to all who wish for our country freedom in every possible form. Here is the story.

Immediately after the outbreak of the war the New York Section of this society, foreseeing economic distress from possible shortage of dyestuffs, appointed a representative and politically non-partisan committee to report on the prerequisites of an adequate self-contained American dyestuff industry: The report, unanimously adopted by this the largest of our local sections, recommended congressional enactment of protective duties amounting to thirty per cent. ad valorem and $7\frac{1}{2}$ cents per pound specific on finished dyestuffs, one half these amounts on intermediates and an effective anti-dumping clause. The protective rates of this report formed the basis of the Hill bill, introduced in the house on the opening day of Congress by

Representative Ebenezer J. Hill, of Connecticut. In January, 1915, hearings were held on this bill and there was presented the unusual sight of both producers and consumers urging the Ways and Means Committee to report the bill favorably. In spite of this unanimity the report was not forthcoming. Public demand for such legislation, however, increased and finally, after a conference between leading members of the controlling party in both the Senate and the House of Representatives of a large number of producers and consumers, a form of legislation was proposed by the congressional representatives which embodied the ad valorem rates of the New York Section but reduced the specific duties by one third, such specific duties to continue in full force for a period of only five years, after which time they were to decrease twenty per cent. annually. Another feature was the proviso that if at the expiration of five years American dyestuff factories were not producing sixty per cent. of the values (note this carefully) of American consumption, the specific duties were to be immediately and completely repealed by Presidential proclamation.

In spite of the lowered specific duties this agreement, confirmed by authorized interviews from Washington, led to increased activity by many producers. It is not difficult to imagine, therefore, the amazed surprise which greeted the appearance of the dyestuff section of the general revenue bill, which, while it contained all of the above, showed one other totally unexpected feature, namely, the exclusion of indigo and alizarin and their derivatives from the benefit of the special duty of 5 cents per pound. Such an exception was fatal to the purposes of the bill. The *ad valorem* duty alone would not suffice to promote and encourage the manufacture of synthetic indigo and alizarin. No scientific or technical justification existed for discrimination against these two coal tar dyes, which constitute 29 per cent. of the values of our consumption. Furthermore, the manufacture of at least 10 per cent. of dyestuffs could not for the present be attempted in this country because of existing foreign patents. Such considerations show that the possibility of expansion of the home industry within the five-year period to 60 per cent. of the values of consumption would be precluded by the terms of the bill itself. Consequently the duration of the special duty for any dyestuff would be restricted to the initial five-year period. Evidently our lawmakers had surpassed the skill of the alchemists, in that they had demonstrated their ability to transform at least bricks into gold.

Pressed for a justification of the exclusion of indigo and alizarin, the chairman of the Ways and Means Committee made explanation on the floor of the house in a speech which by previous agreement was to conclude the debate. In this speech reference was made to the satisfactory character of the conference with the representatives of the industries; individual manufacturers were referred to as not desiring full protection for indigo and alizarin; and no justification on scientific or technical grounds was attempted. Then the dyestuff section of the bill was adopted by a party vote. Immediately briefs were filed with the subcommittee of the Senate Committee on Finance in charge of this section of the House bill. These briefs included letters and telegrams from the individuals referred to in the house debate refuting the statements made by the chairman of the Ways and Means Committee. Moreover they pointed out clearly that the exception of indigo and alizarin was not in accordance with the original conference agreement and would prove disastrous to the entire industry. The Senate subcommittee

was convinced and accordingly struck from the bill the objectionable exceptions and in addition included natural indigo and coal-tar medicinals and flavors, additions in every sense logical, and giving to the classifications of the bill a thoroughly comprehensive character.

With the appearance of the printed hearings and briefs an interesting exhibit was made by the plea of a large consumer of indigo located at Greensboro, North Carolina. Not content with the discrimination given indigo in the measure as passed by the house, he urged its complete removal to the free list. No other consumer of indigo joined in this request. The subcommittee rejected his plea.

The completed section of the revenue bill was then endorsed by the full committee and by the majority-party conference, and was adopted by the senate. In the last hours of the session the section emerged from the joint conference of the majority-party conferees from both senate and house with indigo and alizarin excluded from the special duty, and carrying along with them, as a sort of legislative by-product, medicinals and flavors. As no record is published of the proceedings of conference committees we are left to assumptions as to the influence which prevailed to give the section its final form; but in the light of the history of the legislation and the personnel of the conferees, as published in the *Congressional Record*, it is not difficult to imagine whose influence was determinative in maintaining the discriminatory feature of the original house legislation, against which united protest had been made save for the voice of one consumer. The section in this disastrous form was then adopted by both senate and house and is now the law.

Such is the answer of the present congress to the nation-wide (with one exception) call for adequate protective duties for the encouragement and upbuilding of this much needed industry. The claims of this industry, upon non-partisan legislative aid are reasonable, because of initial difficulties in manufacture and the character of the competition to be met after the war. These claims are also commanding, through the intimate connection of the industry with adequate munitions for our army and navy. Nevertheless, the measure professedly enacted for its upbuilding stands to-day stamped with the evidence either of the most specialized form of legislation for special interests; or of stupidity, as a tax placed upon the consumer without the benefit of an assured home industry; or of stubborness in maintaining a wrong position rather than admit an error in judgment. I do not believe the citizens of this nation will set the seal of their approval upon such legislation.

RELATIONS TO NATIONAL THOUGHT

In the light of the activities of the past year let us ask ourselves frankly—what is the position of chemistry to-day in the thought of the nation? No one can doubt that it occupies a much more prominent place. This is due in part to the superb response American chemists have given to the sudden call upon their resources and ingenuity, in part to the advertisement through the press of the important rôle of the German chemist in the industrial upbuilding of that nation, and to the constant repetition of the phrase that "modern war is largely a matter of chemistry and engineering."

Concrete evidence of increased appreciation of chemistry is furnished by the Second National Exposition of Chemical Industries now in progress. Its exhibitors are more than double those of last year; its exhibits show many new products, born of the exigencies of the year: its underlying thought has been broadened to include

a more systematic showing of the importance of chemistry to the wise use of natural resources; and its purposes have gained a far wider and more appreciative understanding by our people as a whole.

Again we find evidence in the recent issuance of a special chemistry edition by a prominent trade journal, *The Manufacturers Record*. The purpose of that unusual issue was not merely to emphasize the advantages of a great section of the country for the upbuilding of chemical industries, but of far greater importance it sought to vitalize the thought of the people of that section as to the fundamental character of chemistry among the factors of industrial development.

Furthermore, it must be noticeable to all that slowly but surely an educational campaign is getting under way in the daily press and in periodical literature which will eventually result in the arousal of our people to a full comprehension of the value of chemistry as a national asset.

These are simply signs of the times. We can not, however, feel that the national thought has as yet grasped in its entirety the all pervading influence of chemistry so long as Cornell University, with its strong chemistry staff, must delay the replacement of its burned laboratory through lack of funds; so long as Johns Hopkins University, the cradle of American chemical research, must undergo such struggle for the means to erect a new laboratory on the beautiful new site of that institution; so long as members of congress view chemists and chemical manufacturers as fit subjects for hard bargaining; so long as railway presidents feel that chemistry has no part in the development of the natural resources of the sections traversed by their lines; and so long as waste in any form is allowed to continue unheeded.

Further expansion of the relations of chemistry to the national thought involves—

First. Continued educational effort through the press. Plans for such are being evolved, and these plans are meeting the quickened sympathy of the leaders of the press. Each of us must cooperate in this work. As a class we are not qualified to write in popular style, and in the past we have not troubled ourselves very much about such matters; but we can furnish facts and sound opinion to those who have the work and responsibility of popular presentation, and we should stand ready, each in his own community, to share in such cooperative effort.

Second. An awakening of the financial interests of the country to the fact that the ways of chemistry are not mysterious but applied common sense which constitutes a sure guide.

Third. Continued worthiness of our own efforts. This is our direct responsibility. Thoroughness of training, untiring zeal in work, aggressive conservatism in counsel, courage in new undertakings, independence in thought, generous cooperation, constant search for truth—these must surely lead us to that vantage ground where we can best serve this our country.

CHAS. H. HERTY

ON THE ANALYSIS OF LIVING MATTER THROUGH ITS REACTIONS TO POISONS[1]

I AM told that the chair of Section I has not been held by a pharmacologist for many years, and I wish to express the pleasure I feel in the honor that has been done me personally, and even more in the recognition vouchsafed to one of the youngest handmaidens of medicine. Pharmacology

[1] Address before the Physiological Section of the British Association for the Advancement of Science, Newcastle-on-Tyne, 1916.

has too often shared the fate of the bat in the fable: when we appeal for support to the clinicians we are told that we represent an experimental science, while when we attempt to ally ourselves with the physiologists we are sometimes given the cold shoulder as smacking too much of the clinic. As a matter of fact, we should have a footing in each camp, or, rather, in each division of the allied forces. And the more recent successes in the application of pharmacology to diseased conditions are now beginning to gain it a rather grudging recognition from clinicians, while the alliance with the biological sciences is being knit ever more closely. The effect of chemical agents in the living tissues has assumed a new and sinister aspect since the enemy has resorted to the wholesale use of poisons against our troops, but I must leave this for the discussion to-morrow.

I wish to-day to discuss an aspect of pharmacological investigation which has not been adequately recognized even by the pharmacologists themselves and which it is difficult to express in few words. In recent years great advances have been made in the chemical examination of the complex substances which make up the living organism, and still greater harvests are promised from these analytic methods in the future. But our progress so far shows that while general principles may be reached in this way, the chemistry of the living organ, like the rainbow's end, ever seems as distant as before. And, indeed, it is apparent that the chemistry of each cell, while possessing general resemblances, must differ in detail as long as the cell is alive. No chemistry dealing in grams, nor even microchemistry dealing in milligrams, will help us here. We must devise a technique dealing with millionths to advance towards the living organism. Here I like to think that our work in pharmacology may perhaps contribute its mite; perhaps the action of our drugs and poisons may be regarded as a sort of qualitative chemistry of living matter. For chemical investigation has very often started from the observation of some qualitative reaction, and not infrequently a good many properties of a new substance have been determined long before it has been possible to isolate it completely and to complete its analysis. For example, the substance known now as tryptophane was known to occur in certain substances and not in others long before Hopkins succeeded in presenting it in pure form. And in the same way it may be possible to determine the presence or absence of substances in living tissues, and even some of their properties, through their reaction to chemical reagents, that is, through the study of the pharmacology of these tissues. A simple example may render the point clearer: It is possible that if the toxicity of the saponins to different cells were accurately known, the relative importance of the lecithins in the life of these cells might be estimated, and this might give a hint to the chemist in approaching their analysis. I do not claim that pharmacological investigation can at present do much more than the qualitative testing of the tyro in the chemical laboratory, but even a small advance in the chemistry of living matter is worthy of more attention than this has received hitherto.

All forms of living matter to which they have free access are affected by certain poisons, and some of these have obvious chemical properties which suggest the method of their action; thus the effects of alkalies and acids and of protein precipitants hardly need discussion. Others such as quinine and prussic acid, which also affect most living tissues, have a more subtle action. Here it is believed that the common factor in living matter which is changed by these

poisons is the ferments, and quinine and prussic acid may therefore be regarded as qualitative tests for the presence of some ferments, notably those of oxidation, and, in fact, have been used to determine whether a change is fermentative in character or not. Formaldehyde was stated by Loew to be poisonous to living matter through its great affinity for the NH_2 group in the proteins, a suggestion which has perhaps not received enough attention of late years, during which the importance of this group in proteins has been demonstrated. The toxicity of other general poisons, such as cocaine, is more obscure. But what has been gained already in this direction encourages further investigation of the action of the so-called general protoplasm poisons and further efforts to associate it with the special constituents of the cell.

In other poisons the action on the central nervous system is the dominating feature, and among these the most interesting group is that of the simple bodies used as anesthetics and hypnotics, such as ether, chloroform and chloral. The important use of this group in practical medicine has perhaps obscured the fact that they act on other tissues besides the central nervous system, though we are reminded of it at too frequent intervals by accidents from anesthesia. But while they possess this general action, that on the nervous tissues is elicited more readily. Not only the nerve-cell, but also the nerve-fiber react to these poisons, as has been shown by Waller and others. And even the terminations are more susceptible than the tissues in which they are embedded, according to the observations of Gros. The selective action on the nervous tissues of this group of substances has been ascribed by Overton and Meyer to the richness in lipoid substances in the neurons, which leads to the accumulation of these poisons in them, while cells containing a lower proportion of lipoid are less affected. In other words, Overton and Meyer regard these drugs as a means of measuring the proportion of lipoids in the living cell. This very interesting view has been the subject of much discussion in recent years, and, in spite of the support given it by several ingenious series of experiments by Meyer and his associates, no longer receives general acceptance. Too many exceptions to the rule have to be explained before the action of these bodies can be attributed wholly to their coefficients of partition between lipoids and water. At the same time the evidence is sufficient to justify the statement that the property of leaving water for lipoid is an important factor in the action of the bodies, although other unknown properties are also involved in it. And whatever the mechanism of the characteristic action, these substances in certain concentrations may be regarded as tests for the presence of nervous structures and have been employed for this purpose.

Other bodies acting on the nervous system have a much narrower sphere. Morphine and strychnine, for example, appear to be limited to the region of the nerve-cells, but there is still doubt whether they affect the cell-body alone or the synapses between certain of its processes. They have not been shown to act on peripheral nervous structures in vertebrates, nor on any but specific regions of the central nervous system. Nor has it been established that they affect invertebrates. The substance with which they react is obviously limited by very narrow boundaries around the nerve-cell.

More interest has been displayed in recent years in the alkaloids which act on the extreme terminations of various groups of nerves. These are among the most specific reagents for certain forms of living matter which we possess. Thus, if an organ reacts

to adrenaline, we can infer that it contains the substance characteristic of the terminations of sympathetic fibers, with almost as great certainty as we infer the presence of a phenol group from the reaction with iron. And this sympathetic substance can be further analyzed into two parts by means of ergotoxine, which reacts with the substance of the motor sympathetic ends, while leaving that of the inhibitory terminations unaffected. Similarly the endings of the parasympathetic nerves are picked out with some exceptions by the groups represented by atropine and pilocarpine, and here again there must be some definite substance which can be detected by these reagents.

Further, some light has been thrown on, at any rate, one aspect of these nerve-end substances by the observation that they all react to only one optical isomer in each case. Thus the dextro-rotatory forms are ineffective in both atropine and adrenaline, and this suggests strongly that the reacting body in the nerve-ends affected by these is itself optically active, though whether it bears the same sign as the alkaloid is unknown. This very definite differentiation between two optical isomers is not characteristic of all forms of living matter. For example, the heart muscle seems to react equally to both lævo- and dextrocamphor. The central nervous system contains substances which react somewhat differently to the isomers of camphor and also of atropine, but the contrast is not drawn so sharply as that in the peripheral nerve-ends.

Another test alkaloid is curarine, the active principle of curare, which in certain concentrations selects the terminations of the motor nerves in striated muscle as definitely as any chemical test applied to determine the presence or absence of a metal.

The tyro in the chemical laboratory is not often fortunate enough to be able to determine his analysis with a single test. He finds, for example, that the addition of ammonium sulphide precipitates a considerable group of metals, which have then to be distinguished by a series of secondary reactions. The pharmacologist, as an explorer in the analysis of living matter, also finds that a single poison may affect a number of structures which appear to have no anatomical or physiological character in common. But as the chemist recognizes that the group of metals which react in the same way to his reagent have other points of resemblance, so perhaps we are justified in considering that the effects of our poison on apparently different organs indicate the presence of some substance or of related substances in them. A great number of instances of this kind could be given, and in many of these the similarity in reaction extends over a number of poisons, which strengthens the view that the different organs involved have some common reacting substance.

One of the most interesting of these is the common reaction of the ends of the motor nerves in striated muscle and of the peripheral ganglia of the autonomic system. It has long been known that curare and its allies act in small quantities on the terminations of the motor nerves in ordinary muscle, while larger amounts paralyze conduction through the autonomic ganglia. More recently it has been developed by the researches of Langley that nicotine and its allies, acting in small quantities on the ganglia, extend their activities to the motor ends in large doses. Some drugs occupy intermediate positions between nicotine and curare, so that it becomes difficult to assign them to either group. These observations appear to leave no question that there is some substance or aggregate common to the nerve-ends in striated muscle and to the autonomic ganglia. As to the exact anatomical position of this substance, there

is still some difference of opinion. Formerly it was localized in the terminations of the nervous fibers in the muscle and ganglia, but Langley has shown that in the latter the point of action lies in the ganglion-cell itself, and his researches on the antagonism of nicotine and curare in muscle appear to show that the reacting substance lies more peripherally than was supposed, perhaps midway between the anatomical termination of the nerve and the actual contractile substance. Another analogy in reaction has been shown to exist between the ganglia and the terminations of the post-ganglionic fibers of the parasympathetic, for Marshall and Dale have pointed out that a series of substances, such as tetramethyl-ammonium, affect each of these in varying degrees of intensity. The specific character of the reaction is shown by the fact that while it is possessed by the tetramethyl-ammonium salts, the tetraethyl-ammonium homologues are entirely devoid of it.

Another close relationship is shown by the reaction of the glucosides of the digitalis series on the heart and vessels. These all act on the muscle of the heart, and in higher concentration on that of the vessel-walls. There must therefore be a common base in these which is affected by the drugs. And the existence of this is perfectly intelligible in view of the fact that the heart is developed from the vessels. A more obscure relationship is shown by the reaction of this group to the inhibitory cardiac center in the medulla, which is thrown into abnormal activity by their presence in the blood, as has been shown alike by clinical and experimental observations. A similar relation is shown by the common reaction of the heart-muscle and the vagus center to aconitine and some other related alkaloids. On the other hand, the saponin series, which shows a closer relationship to the digitalis bodies in the heart-muscle, is devoid of its characteristic action on the medulla. The reacting substance in the heart is thus capable of responding to digitalis, saponin and aconitine, while that in the vagus center can associate only the first and last and is not affected by the saponins; the common reactions indicate that the two are related, while the distinctive effect of saponin shows that they are not identical. A similar relationship may be drawn from the action of morphine and the other opium alkaloids on pain sensation, on respiration, and on the movements of the alimentary tract. Exact determinations of the relative power of these alkaloids in these regions are not at our disposal as yet, but sufficient is known to suggest that while morphine affects a common substance in the medullary center and the intestinal wall, the other members of the series act more strongly in one or other position.

It was long ago pointed out that caffeine affects both kidney and muscle-cell, and Schmiedeberg has attempted to correlate the intensity of action of the purine bodies at these points and to measure the probable diuretic action by the actually observed effect on the contraction of muscle. Other reactions of the kidney suggest a relationship to the wall of the bowel. For example, many of the heavy metals and some other irritant bodies act strongly on the kidney and bowel, and again, according to one view of renal function, many of the simple salts of the alkalies affect the kidney in exactly the same way as the bowel-wall. This last may, however, be due to the physical properties of the salts, and the likeness in reaction to those of kidney and bowel, which is striking enough, may arise from a likeness in function of the epithelium rather than from any specific relationship to the salts which is not common to other forms of living matter.

Many other examples might be cited in which organs which are apparently not related, either morphologically or in function, react to poisons in quantities which are indifferent to the tissues in general. And this reaction in common can only be interpreted to mean that there is some substance or group of related substances common to these organs. The reaction may differ in character; thus a drug which excites one organ to greater activity may depress another, but the fact that it has any effect whatever on these organs in preference to the tissues in general indicates some special bond between them, some quality which is not shared by the unaffected parts of the body. I have, therefore, not differentiated between excitation and depression in discussing this relation. One is tempted to utilize the nomenclature introduced by Ehrlich here and to state that the common reaction is due to the presence of haptophore groups while the nature of the reaction (excitation or depression) depends on the character of the toxophore groups. But while these terms may be convenient when applied to poisons whose chemical composition is altogether unknown, they merely lead to confusion when the question concerns substances of ascertained structure. Thus, as Dale has pointed out, it is impossible to suppose that such substances as tetramethyl-ammonium and tetraethyl-ammonium owe the difference in reactions to specific haptophore groups in the one which are absent in the other. It seems more probable that in this instance and in others the difference in the effect of these bodies in the tissues arises from differences in the behavior of the molecule as a whole than in differences in the affinities of its special parts; that is, that the action of these poisons is due to their physical properties rather than to their chemical structure, although this, of course, is the final determining cause.

In the same way the common reaction of tissues, which I have so far ascribed to their possessing some substance in common, may arise from community of physical relationship, and I wish to avoid the implication borne by the word "substance," which I have used in the widest sense, such as is justified perhaps only by its historical employment in theological or philosophical controversy. The reaction of living tissue to chemical agents may arise from a specific arrangement in its molecule, but may equally be attributed to the arrangement of the molecules themselves. And the curious relationships in the reactions of different tissues may indicate, not any common chemical factor, but a common arrangement of the aggregate molecules. We are far from being able to decide with even a show of probability which of these alternatives is the correct one, and my object to-day has been to draw attention to these relationships rather than to attempt their elucidation. Hitherto the speculative pharmacologist has been much engaged in comparing the chemical relationship of the drugs which he applies to living tissues; much useful knowledge has been incidentally acquired, and the law has been formulated that pharmacological action depends directly on, and can be deduced from chemical structure. This view, first elaborated in this country, has in recent years shared the fate of other English products in being advertised from the housetops and practically claimed as the discovery of more vociferous investigators. On examining the evidence, old and new, one can not help feeling that attention has been too much directed to those instances which conform to the creed, while the far more numerous cases have been ignored in which this so-called rule fails. The difficulties are very

great; for example, what chemical considerations can be adduced to explain why the central nervous tissues react differently to bromide and chloride, while to the other tissues these are almost equally indifferent; or how can the known chemical differences between potassium and sodium be brought into relation with the fact that they differ in their effects in almost every form of living tissue?

Less attention has been paid to the other factor in the reaction, the properties of the living tissue which lead one cell to react to a poison, while another fails to do so. I have pointed out some curious relations between different organs, but much needs to be done before any general view can be obtained. Further detailed examination of the exact point at which poisons act, and much greater knowledge of the physical characters of the drugs themselves and of the relation of colloid substances to these characters, are needed. We must attempt to classify living tissues in groups not determined by their morphological or even functional characters, but by their ability to react to chemical agents. Advance is slow, but it is continuous, and if no general attack on the problem is possible as yet, our pickets are at any rate beginning to give us information as to the position of the different groups to be attacked. And when a sufficient number of these qualitative reactions have been ascertained for any form of living matter, it may be possible for some Darwin to build a bridge from the structural chemistry of the protein molecule to the reactions of the living cell. We can only shape the bricks and mix the mortar for him. And my purpose to-day has been to indicate how the study of the effects of drugs on the living tissue may also contribute its mite towards the great end.

A. R. Cushney

FIELD MEETINGS OF THE ASSOCIATION OF AMERICAN STATE GEOLOGISTS

The state geologists of Connecticut, Florida, Illinois, New Jersey, New York, North Carolina, Ohio, Oklahoma, West Virginia and Wisconsin, the director and chief geologist of the Federal Survey, together with the staff of the New York Geological Survey and a few invited guests were in attendance on some or all of the field meetings of the Association of American State Geologists on September 4 to 9. The meetings were held in New York state by invitation of the director of the New York Geological Survey, Dr. John M. Clarke.

September 4–5. The field meetings began September 5 after a preliminary meeting on the previous evening in the office of the director in the State Museum at Albany. The first excursion was by autobus to the Indian Ladder of the Helderberg escarpment, where the classic Helderberg section is well developed. The more refined subdivisions were pointed out by Dr. J. M. Clarke, Dr. R. Ruedemann and Dr. E. O. Ulrich, and the reasons for the subdivisions and for some recent changes in nomenclature were discussed. Contacts between the Indian Ladder beds (Hudson River) and Brayman shales, and between the Brayman shales and Manlius limestone were studied and the cause of the brecciated character of the beds was considered.

The karst topography developed where the Onondaga limestone reaches the surface was seen as the party motored to Thompson's Lake. This lake is believed to rest in a solution basin from which the water drains through underground passages.

At Altamont the party was most agreeably entertained at tea by Mrs. John Boyd Thacher, donor to the state of New York of the Helderberg escarpment, of which the Indian Ladder is the most picturesque portion and which is known as the John Boyd Thacher Park. In the evening the party assembled in the office of the director of the New York Survey for a conference.

September 6. Wednesday morning the party went by train to Saratoga Springs, where it

was met by the superintendent, Mr. Jones, the engineer, Mr. Anthony, and Dr. Ferris, of the Mineral Springs Reservation, under whose guidance the various springs and the fault along which they occur were seen. The structural features of the region and the relation of the fault to the underground water was pointed out by members of the New York Geological Survey. The party then proceeded to the remarkable Cryptozoan ledge (property of the State Museum) which is a glaciated algal reef consisting of several beds of cabbage-like, calcareous algæ in the Hoyt limestone (Upper Cambrian).

A delightful luncheon was tendered the geologists by Mrs. J. Townsend Lansing at Saratoga. In the afternoon a visit was made to historic Crown Point on Lake Champlain with its ruins of Fort St. Frederic (1731) and Fort Amherst (1759), the latter being one of the most important colonial fortifications, said to have cost 2,000,000 pounds. On the parade grounds and in near-by exposures Ordovician rocks with their contained fossils were studied.

September 7. Thursday morning was spent at Mineville where, through the courtesy of the Witherbee, Sherman Co., the members of the party were given an opportunity to visit some of the underground workings of the great magnetite deposits. The magnetite bodies occur in lenses, sheets and pods, surrounded by light-colored gneiss and syenite, and yield both concentrating and high-grade ores, with low and high phosphorus content. The output of the mines is more than 1,000,000 tons a year, not including apatite, which as a by-product is manufactured for fertilizer.

In the afternoon exposures of the Precambrian showing faulting, folding and other complexities of structure were seen under the direction of Assistant State Geologist D. H. Newland. The complex relations of the various gneisses and schists, Grenville limestones, syenite, gabbro and trap dikes were studied in most extraordinary exposures along the Delaware and Hudson railroad track.

At an informal meeting Friday evening at Port Kent, among other questions of general interest, the following topics were discussed: the advisability of encouraging technical schools to require a more adequate training in geology for civil engineers; the necessity of bringing to the attention of the officers of the regular army and militia the importance of a thorough understanding of topographic maps as an essential preparation for military maneuvers; the desirability of offering to the government the services of the state surveys in preparations for national defense.

September 8. The party left Port Kent, where the night had been spent, for the picturesque Ausable Chasm, a post-glacial gorge in Potsdam sandstone, whose course has been determined in large measure by faulting and jointing.

By invitation of the Rt. Rev. Mgr. John P. Chidwick, president of the Catholic Summer School at Cliff Haven on Lake Champlain, the geologists were guests of the school for luncheon at the Champlain Club.

An interesting fourchite dike near the summer school and fine exposures of the Chazy and Beekmantown limestones occupied the time of the party until it was taken by Professor G. H. Hudson to Valcour Island. Under his guidance it was made possible to see the results of his investigations of the fault problems of the island. Interformational breccias, storm tossed reef masses, and tornado records are also among the interesting geological features shown. Professor and Mrs. Hudson gave a camp supper to the members of the party, a feature which added a particularly enjoyable evening to a day full of pleasure and profit. At its close the party went to Plattsburg, where the night was spent aboard the steamer *Vermont*, preparatory to the trip to Burlington in the morning.

September 9. At Burlington, Vermont, the party broke up, some returning home and some remaining with Professor G. H. Perkins, under whose guidance they saw the great overthrust fault on the shore of Lake Champlain near Burlington, in which light-colored Cambrian sandstones overlie black Utica shales; the buildings and museum of the University of Vermont; and finally the great

marble quarries at West Rutland, to which they were taken in automobiles furnished through the courtesy of the Vermont Marble Company.

The great success of these field meetings was due not only to the region traversed, which is unusually interesting geologically and historically, but also to the care with which every detail was planned and executed, and the pains which the director of the New York State Geological Survey and his staff took to provide for the comfort and pleasure of the party.

This report was written at the request of the busy secretary of the association, Dr. W. O. Hotchkiss, by the undersigned guest of the association. HERDMAN F. CLELAND

WILLIAMSTOWN, MASS.

THE NEWCASTLE MEETING OF THE BRITISH ASSOCIATION

WE learn from the account of the meeting in *Nature,* that the attendance was 626, the smallest since the first meeting held in York in 1831. It is said, however, that the attendance at the meetings of the sections was quite up to the average.

The general committee adopted a recommendation of the council that research committees should have power to report through organizing committees of sections to the council at any time when the association is not in annual session. Hitherto research committees have had to await the annual meeting before presenting their reports, even when their conclusions call for early action. Under the new rules this will no longer be necessary if the organizing committee to which a research committee presents its report considers it desirable to report direct to the council. Another alteration of the rules of the association makes it possible for the council to include upon research committees persons who are not members of the association, but "whose assistance may be regarded as of special importance to the research undertaken."

The general treasurer has reported to the council that Mr. M. Deshumbert proposed to leave a legacy of about £5,000 to the association, subject to the condition that his wife and her sister should receive the interest during their lifetime.

The new members of council elected by the general committtee are Mr. R. A. Gregory, Dr. S. F. Harmer, Dr. E. J. Russell, Dr. A. Strahan and Professor W. R. Scott. An invitation to meet in Cardiff in 1918 was unanimously and gratefully accepted by the committee.

The total grants of money appropriated by the general committee for purposes of research committees proposed by the various sections amounted to £602. The subjects and grants are as follows:

Section A.—Seismological observations, £100; annual tables of constants, £40; mathematical tables, £20; gravity at sea, £10.

Section B.—Dynamic isomerism, £15; Eucalypts, £30; absorption spectra, etc., of organic compounds, £10.

Section C.—Red Sandstone rocks of Kiltorcan, £4; Paleozoic rocks, £20.

Section D.—Biology of the Abrolhos Islands, £6; inheritance in silkworms, £20.

Section F.—Fatigue from an economic point of view, £40; replacement of men by women in industry, £20; effects of war on credit, etc., £10.

Section G.—Stress distributions, £40.

Section H.—Artificial islands in the lochs of the Highlands of Scotland, £5; physical characters of ancient Egyptians, £2, 12s. (unexpended balance); Paleolithic site in Jersey, £30; excavations in Malta, £20; distribution of Bronze age implements, £1, 14s. (unexpended balance).

Section I.—Ductless glands, £15; psychological war research, £10.

Section K.—Physiology of heredity, £45; ecology of fungi, £8.

Section L.—School books and eyesight, £5; work of museums in education and research, £15; effects of "free-place" system upon education, £15; science teaching in secondary schools, £10; mental and physical factors involved in education, £10.

Corresponding Societies' Committee.—For preparation of report, £25.

SCIENTIFIC NOTES AND NEWS

SIR CHARLES PARSONS, the engineer, has been elected president of the British Association for the meeting to be held at Bournemouth in September next.

THE executive committee of the Pacific Division of the American Association for the Advancement of Science has elected Dr. John Casper Branner, president emeritus of Stanford University, as president of the division for the year 1916–17. The executive committee includes in addition to the president of the division, the vice-president, Dr. D. T. MacDougal, director of the department of botanical research, Carnegie Institution of Washington, Tucson, Arizona, who is chairman of the committee, and the following elected members: E. C. Franklin, professor of chemistry, Stanford University; T. C. Frye, professor of botany, University of Washington, Seattle; C. E. Grunsky, consulting engineer and former member of the Panama Canal Commission, San Francisco; G. E. Hale, director of the Mount Wilson Solar Observatory, Carnegie Institution of Washington, Pasadena; V. L. Kellogg, professor of entomology, Stanford University, now with the commission for relief in Belgium, Brussels; A. C. Lawson, professor of mineralogy and geology, University of California; and E. P. Lewis, professor of physics, University of California.

THE American Chemical Society will hold an adjourned meeting in affiliation with the American Association for the Advancement of Science in New York City during convocation week. The society originally planned to meet with the association at that time, but finally decided that it was best to meet simultaneously with the National Exposition of Chemical Industries, which it was necessary to hold in September. The next annual meeting of the society will be held in Boston in September, 1917. Dr. E. G. Love, of New York City, has been elected treasurer of the society, to succeed Dr. A. B. Hallock, who has acted as treasurer for the past twenty-five years. Dr. Charles H. Herty, head of the department of chemistry in the University of North Carolina and the present president of the American Chemical Society, has been elected editor and manager of the *Journal of Industrial and Engineering Chemistry*. Dr. Herty will take up this work in New York City on January 1. The journal has hitherto been edited by Professor M. C. Whittaker, in charge of industrial chemistry at Columbia University, who is unable to give his entire time to the work.

WE learn from *Nature* that the fourth annual meeting of the Indian Science Congress will be held at Bangalore on January 10–13, with Sir Alfred Bourne as president. The following sectional presidents have been appointed: Mr. J. MacKenna (Pusa), agriculture and applied chemistry; the Rev. D. Mackichan (Bombay), physics; Dr. Zia Uddin Ahmad (Aligarh), mathematics; Dr. J. L. Simonsen (Madras), chemistry; Mr. K. Ramunni Menon (Madras), zoology; Mr. C. S. Middlemiss (Calcutta), geology.

PROFESSOR J. G. SANDERS, the newly appointed Pennsylvania State Economic Zoologist, has begun his work. He has been visiting the agricultural region with Governor Brumbaugh and has taken up the reorganization of his division.

DR. WILLIAM H. DAVIS, of Boston, has been appointed chief statistician, division of vital statistics, United States Bureau of the Census. Dr. Davis has been the vital statistician of the Boston Health Department for some years, and was appointed to his present office on the basis of a civil service examination.

DR. SIDNEY D. JONES has been placed in charge of the Fort Dodge (Iowa) Clinical and Roentgen-Ray Laboratory, succeeding Dr. Thomas H. Glenn.

DR. WALTER DILL SCOTT, professor of psychology at Northwestern University, is on leave of absence for the current year acting as director of the Bureau of Salesmanship Research in the Carnegie Institute of Technology, Pittsburgh, Pa.

PROFESSOR GEORGE H. WHIPPLE, professor of sanitary engineering at the Massachusetts Institute of Technology and secretary of the School for Health Officers, has been retained by the New York State Board of Health as scientific adviser in the matter of the garbage nuisance on Staten Island. Here the plant of a private contractor was licensed and

erected despite the protests of the citizens, and on an appeal to the state an investigation was set on foot. Professor Whipple is associated with Theodore H. Horton, chief engineer of the state department.

Nature reports that the king in council has appointed Mr. Arthur Henderson, M.P., a member of the committee of the privy council for the organization and development of scientific and industrial research. The other non-official members of the committee are Lord Haldane, the Right Hon. A. H. D. Acland, and the Right Hon. J. A. Pease, M.P. Mr. Henderson was the president of the board of education when the government's research scheme was published in July of last year. As such he was a member of the committee, which includes also, as official members, the lord president of the privy council, the chancellor of the exchequer, the secretary for Scotland, the president of the board of trade, and the chief secretary for Ireland.

PROFESSOR C. T. BRUES, of the Bussey Institution, Harvard University, has been investigating the possible rôle of insects in the transmission of infantile paralysis during the epidemic of this disease in New York City. These studies are being carried on under the auspices of the New York city board of health.

GENERAL W. C. GORGAS, U. S. A., chairman of the Yellow Fever Commission of the Rockefeller Foundation, with other members of the commission arrived in New York last week, from San Juan. The commission visited Chile, Bolivia, Peru, Ecuador and Panama and was obliged to return to New York to take a steamship for Para, Rio de Janeiro and Santos. Besides General Gorgas, who got four months' leave of absence from the army to aid the investigation, the commission includes Dr. Henry R. Carter, United States Public Health Service, clinician; Dr. Juan Guiteras, head of Public Health Service of Cuba, clinician and general adviser; Dr. C. C. Lyster, clinician; Dr. Eugene R. Whitmore, pathologist, and Dr. William D. Wrightson, sanitation engineer.

SIR ERNEST SHACKLETON is said to be now hastening the settlement of matters in connection with the Weddell Sea party of his expedition so as to get over to Australia at the earliest possible moment. Through the generosity of the commonwealth and New Zealand governments the *Aurora* is being repaired and refitted to go south to rescue the ten men of Lieutenant Mackintosh's party marooned at the Ross Sea base.

DR. J. N. ROSE, of the Carnegie Institution of Washington, left on October 4 for another trip to the deserts of South America. This time he will visit the coasts of Venezuela, where many new species of cactuses have been collected and described.

DR. CHRISTEN LUNDSGAARD left Copenhagen on September 21 for New York. He is the first Danish physician to receive an allowance from the Niels Poulsen American-Scandinavian Foundation. He will study at the Rockefeller Institute and later will travel and pursue research work at other institutions in the United States.

AT Harvard University an "Infantile Paralysis Commission" for the treatment and study of infantile paralysis has been appointed consisting of Robert Williamson Lovett, A.B., M.D., chairman, professor of orthopedic surgery; Milton Joseph Rosenau, M.D., A.M., professor of preventive medicine and hygiene; Francis Weld Peabody, A.B., M.D., assistant professor of medicine, and Roger Pierce, A.B., secretary.

THE annual autumn meeting of the British Institute of Metals was held on September 20, in the rooms of the Chemical Society, London, Sir George T. Beilby presiding.

A MEMORIAL research laboratory is proposed to the memory of Dr. Earl C. Peck, first assistant resident physician at the Philadelphia Hospital for Contagious Diseases, who died recently from anterior poliomyelitis.

A BIOGRAPHY of the late Professor James Geikie, of Edinburgh University, is in course of preparation, and it would be a great favor if those who have letters or communications of general interest from him would forward

these to Dr. Marion Newbigin, Royal Scottish Geographical Society, Synod Hall, Castle Terrace, Edinburgh. They would be carefully preserved, and returned after being copied. Correspondence is also invited from American men of science and others who came into contact with Professor Geikie in the course of his visits to the states.

Dr. C. T. Clough, for forty years a member of the British Geological Survey, died on August 27, having been run over by a train while examining rock explosives in Scotland.

Professor H. Mohn, the meteorologist, of Christiania, died on September 12, at eighty years of age.

Eric Warr Simmons, a recent graduate of University College, London, a geologist of promise, has been killed in the war.

Dr. Ferdinand Fischer, professor of chemiical technology in the University of Göttingen, has died at the age of seventy-four years.

Henri Fischer, the French student of malacology, has died at the age of fifty years.

The death is announced at the age of sixty-one years of Dr. Francesco Bassani, professor of geology in the University of Naples.

The Hospital for Deformities and Joint Diseases, New York, has received from Mr. Herbert Kauffman, of Pittsburgh, through Dr. H. D. Frauenthal, a gift of one million dollars, to be used for the erection of a new building and as an endowment fund.

Before the Tax Budget Committee of the New York City Board of Estimate it was reported that the attendance at the Metropolitan Museum of Art for the year ending June 30, 1916, was 635,206, as against 778,024 for the previous year. The paid admissions for 1916 were 31,617, as against 40,311. The committee voted $200,000, the same amount as last year, although the request was for $250,000. On the other hand, the American Museum of Natural History showed an increase in attendance, and Cleveland H. Dodge, appearing for the trustees, said this was due to school teachers taking their classes to the museum. The attendance for the year ended June 30 was 870,000, as against 664,215 for 1915. Last year the museum received $212,999, and this year requested $222,000, but only $212,700 was recommended.

The following resolution was unanimously passed at the Dyestuff Conference held during the meeting of the American Chemical Society on Tuesday afternoon in Rumford Hall, the hall being crowded to its utmost capacity.

Whereas, the revenue bill (title, V. Dyestuffs) which recently passed the Senate after hearings of representatives of producers and consumers, accorded to *all* classes of dyestuffs without exception an ad valorem duty of 30 per cent. and a specific duty of five cents per pound, and

Whereas, in the final conference between the House Ways and Means Committee, and the Finance Committee of the Senate, and without further hearings, "Natural and Synthetic Alizarin and Dyes Obtained from Alizarin, Anthracene and Carbazol, Natural and Synthetic Indigo and All Indigoides whether or not obtained from Indigo, and Medicinals and Flavors" were made exceptions and to carry no specific duty and to have only the 30 per cent. ad valorem duty. The Dyestuff Conference of the American Chemical Society, in a meeting held in New York, September 27, without a single dissenting vote, condemns the exception of these dyestuffs from this specific duty, as this exception undermines the very foundation upon which it was hoped that the American dyestuff industry might be built. It makes it impossible for the American manufacturer to meet the requirements of this Bill "if, at the expiration of five years from the date of the passage of the Act, the President finds that there is not being manufactured or produced within the United States as much as 60 per cent. in value of the domestic consumption of these articles, he shall by proclamation so declare, whereupon the special duty imposed by the Section on such articles shall no longer be assessed, levied, or collected."

And Whereas the value of these excepted classes of dyes amounts to approximately 30 per cent. of the dyes consumed in the U. S. A., without considering the dyes patented by foreign manufacturers,

Therefore be it resolved, that we condemn the removal of these dyestuffs from the special tariff accorded to them by the Senate as detrimental to the establishment and development of the Ameri-

can dyestuff industry and subversive of the best interests of the American people.

UNIVERSITY AND EDUCATIONAL NEWS

At the September meeting of the Yale Corporation the treasurer reported further distribution of about $685,000 from the estate of the late Justus S. Hotchkiss of New Haven. Other gifts include approximately $10,000 additional for the Hepsa Ely Silliman Lectureship Fund, from the estate of the late Augustus E. Silliman; $15,000 for the Charles W. Goodyear Memorial Scholarship Fund in the School of Forestry; and $5,000 more from Mrs. Helen Newberry Joy and Messrs. John S. and Truman Newberry for the work of rebuilding and enlarging the Newberry organ in Woolsey Hall.

The *Journal* of the American Medical Association announces that one of the final transactions of the merger of the medical school of the University of Pennsylvania, the Medico-Chirurgical College, and Jefferson Medical College was consummated, September 21, when the real estate holdings of the Medico-Chirurgical College were transferred to the trustees of the university. The college buildings, assessed at $375,550, and two four-story houses, assessed at a total of $54,000, were conveyed for a nominal consideration. These will eventually be conveyed to the city by the university and the buildings demolished, as they are in the line of the new parkway.

The department of botany of the Massachusetts Agricultural College and Experiment Station has been reorganized with the following personnel: A. Vincent Osmun, professor and head of the department; George H. Chapman, research physiologist; P. J. Anderson, associate professor and associate pathologist; Orton L. Clark, assistant professor and assistant physiologist; F. A. McLaughlin, instructor; G. W. Martin, instructor.

Tufts Medical School announces several changes in the faculty. Andrew H. Ryan, M.D. (Washington University), will take charge of the department of physiology. Charles H. Baily, M.D. (Harvard), has been made associate professor of histology. R. Harmon Ashley, Ph.D. (Yale), will take charge of the department of chemistry in the dental and pre-medical school. Arthur L. Chute, M.D., has been advanced from assistant professor to associate professor of surgery, and Gilmore C. Dickey, D.M.D., from instructor to assistant professor of crown and bridge work.

Northwestern University has appointed the following instructors: In the department of mathematics: Rutherford Erwin Gleason, B.A., Charles Edwin Wilder, Ph.D., Frank Edwin Wood, B.A., and Irwin Romans, M.A.; in the department of chemistry: Martin William Lisse, M.S. (University of Washington), and Wallace Jennings Murray, Sc.D. (Geneva, Switzerland), instructors in chemistry; Louis Wade Currier, B.S. (Mass. Tech.), instructor in mining and metallurgy. The following promotions have also been made: George Vest McCauley, Ph.D. (Wisconsin), becomes assistant professor of physics, and Chester Henry Yeaton, Ph.D. (Chicago), assistant professor of mathematics. Henry Andrews Babcock, Ph.D. (Northwestern), has been appointed an instructor in physics.

Frederick Lyons Brown, of Northwestern University, has been appointed instructor in astronomy for the Dearborn Observatory.

Dr. S. Morgulis, of the department of physiological chemistry, college of physicians and surgeons, Columbia University, has been appointed professor of physiology in the Creighton University Medical College, Omaha, Nebraska.

Under the general direction of Mr. A. G. Perkin, who is a son of Sir W. H. Perkin and brother of Professor Perkin, of Oxford, a new staff has been appointed to the dyeing department of the University of Leeds. Some of the members will give special attention to the exclusive requirements of British Dyes (Limited), but most of them will devote their services to work which may best meet the needs of other firms. In addition to the scien-

tific investigation of anilines, the working out of processes, and the study of the constitution of color, particular regard is to be paid to coal tar distillation and the industrial application of cellulose. Another feature will be an experimental dyehouse. Mr. G. H. Frank, M.Sc., and Dr. Oesch, a Swiss expert, are retained on the staff, and with them will be associated Mr. P. E. King, Lieutenant A. E. Woodhead, M.Sc., Professor E. R. Watson, D.Sc., of Dacca College, and, as outside lecturers, Mr. H. P. Hird and Mr. C. F. Cross, both specialists engaged in allied industries.

DISCUSSION AND CORRESPONDENCE

ATMOSPHERIC TRANSMISSION

To the Editor of Science: On page 168 of your issue of August 4, 1916, Mr. Very is unfair to himself, to your readers, and to me. He points out that the Smithsonian Mount Wilson observations of September 20 and September 21, 1914, indicate greater transparency of the atmosphere for the complete, complex solar beam made up of energy of all wave-lengths the greater the air mass. From this he tries to lead your readers into the conclusion that the atmosphere gradually decreased in clearness during our period of observations. Nobody knows better than Mr. Very of Langley's mathematical proof that a complex beam traversing a medium the transmissive power of which varies with the wave-length must necessarily behave in this manner even though the medium is perfectly homogeneous. Pure water or glass would show the same effect. The transmission would continually increase for each successive layer traversed. This is because the less transmissible rays are continually becoming a smaller proportion of the intensity of the whole complex beam the farther it goes through the medium. If our pyrheliometric observations *had not shown* the phenomenon which Mr. Very mentions they would have proved that the sky was growing clearer. The question then only remains whether the effect they do show is of the right magnitude or not. This is settled affirmatively by the results obtained with the spectro-bolometer.

For monochromatic rays the atmospheric transmission should be constant for all air masses, if the atmosphere neither grows clearer nor more opaque. Our spectro-bolometric work shows that this condition was closely fulfilled on the two days in question, as Mr. Very well knows. Having no comfort from the spectro-bolometric work, he omits mention of it, and tries to carry his point with the uninformed by paradoxing.

Mr. Very, however, draws attention to the increase of atmospheric humidity during the observations as indicated by Fowle's measurements. It may be remarked that between air-masses 11.0 and 7.2 on September 20 no appreciable change occurred. Yet that part of the observations gives the same result as the rest, showing that the effect of such small increase of humidity as occurred during the rest of the morning was negligible. Those who consult the original derivation of Fowle's method of estimating atmospheric humidity, are, however, aware that it rests on laboratory experiments extending only to 5 millimeters of precipitable water. For the exceptionally large air masses occurring on September 20 and 21 it was applied to the estimation of over 65 millimeters. It seems as likely that this extreme extrapolation involved inaccuracy, increasing with increasing air-mass rather than that the atmospheric humidity really increased from 3.3 to 4.0 millimeters during so short a time as the first 8 minutes after sunrise. I therefore incline to think that there was very little or no increase at all in atmospheric humidity on September 20 between air masses 19 and 3, although a small increase from 3.3 to 5.2 is indicated by Fowle's results. Later on there was really a small increase of humidity, but it appears to have been insufficient to produce appreciable error in the solar-constant values as calculated from small air masses.

As to the clearness of the sky at Flagstaff, Arizona, in August, 1912, Mr. Very shows that it was clearer there, at 7,000 feet elevation, than he is accustomed to find it near Boston, but he does not show that it was clear sky at Flagstaff. If it was really exceptionally

clear there at that time, it adds one more to the long list of wonders associated with that observatory.

In regard to the third matter, relating to the transmission of terrestrial radiation, I am quite unable to understand Mr. Very's logic. His mind seems to let through the consideration of rays that rise vertically from the earth's surface, but to abolish all thought of those which rise obliquely. Like every other surface, all parts of the earth's surface emit rays in all directions within a hemisphere, and tend to cool by the loss of the energy of all these rays which they emit. The loss is to some extent compensated by rays which reach the earth from every one of these directions, and which at night come mainly from the emission of the atmosphere itself. Mr. Ångström and others have measured at night the excess of the radiation emitted by a horizontal blackened surface, at terrestrial temperature, over the radiation received by such a surface from above. There is no great disagreement in the observation. All observers find the net loss of radiation at 20° C. to be from 0.12 to 0.20 calories per sq. cm. per minute, depending on the state of the atmosphere. But Mr. Very maintains that the whole of this loss represents energy that is transmitted entirely through the atmosphere in direct beams from the earth's surface to space. I see no reason to admit this at all. What is measured is a difference between the energy of two beams of rays, one leaving the surface, the other reaching it. If the atmosphere (taking its entire thickness) was totally opaque to these rays, there would still be a difference in these amounts of energy, because the atmospheric sources are at a lower temperature than the earth's surface.

To determine the transmission of the earth's surface-radiation through the atmosphere, as I define it, one must sum up the total of all radiant energy which, having been emitted by a horizontal fragment of the earth's surface, escapes outside the atmosphere into space, by whatever path, without having suffered true absorption and re-radiation. The sum total just described divided by the original quantity emitted by the same element of surface is the transmission. Perhaps Mr. Very has in mind the coefficient of vertical transmission. This is naturally larger than mine, but it does not serve to indicate the rate of loss of heat of the earth's surface by radiation. That depends on the rate of loss by oblique rays as well as that by normal ones.

C. G. ABBOT

MOUNT WILSON, CALIF.,
August 17, 1916

A REMARKABLE AURORAL DISPLAY

BETWEEN eight and nine o'clock on the evening of August 26 I stepped out on the porch of our cottage on the shore of Lake Douglass in northern Michigan and noticed what I at first mistook for an unusually bright twilight for that date and hour.

Looking up through the tree-tops I saw a curious flickering as of sheet lightning on a bit of cloud. But there was a peculiar streaming movement which at once suggested an auroral phenomenon, although I was looking towards the south! Passing around the house to an open field, I was fairly staggered with such a spectacle of light in motion as had never been dreamed of by any of our family group of eight which at once answered my cry of amazement.

Practically the whole vault of the heavens was alive with light. Light in patches, bands and arches; in streamers, sheets and delicate pencillings. Clear from the northern horizon to the zenith, and far beyond until the southern sky was invaded to within about four degrees of the horizon, and was utilized for the unfolding of the display.

I had seen what I thought to be fine auroras much farther to the north, but had never even heard of one which required almost the entire expanse of the heavens for its staging.

The focus of the spectacle was the zenith itself, and around this was a shifting and irregular zone of light below which almost the entire sky was set with masses of shifting, shimmering radiance constantly changing shape as if the sky were a vast kaleidoscope. It seemed, indeed, as if we stood beneath the

center of the dome of the firmament, whose vault was composed of bands and changing masses of streaming light, the quivering waves of which were surging upward toward the disk of blue at its apex. A brighter arch spanned the northern horizon, and this also was undergoing constant transformation.

It was not the light itself, marvellous as were its mass, zones, banners and steamers, that most thrilled the observers. Such a vast display of light in constant *movement* had never before been seen nor imagined by any of us. The whole heavens shuddered and staggered, shivered into a swirling chaos and reformed again and again in new and still more weird aggregates of shimmering light. Light streamed and wavered, rippled, flickered and pulsated. Now it was in broad waves reaching to the zenith, and now in vibrating bands. Here a broad cone shot up from the northern horizon until its apex pierced the very mid-heavens, and in the twinkling of an eye it was gone. There, from the shifting zones around the zenith, ripples of light passed upward to the blue apical disk. To the naturalist no more apt figure of this rippling motion could be suggested than the waves of light passing along the meridional bands of phosphorescent Ctenophora.

Again, a delicate fringe of pencil points would appear on the upper edge of one or more of the shifting zones and then shoot upward with inconceivable rapidity in sharp vibrating pencillings of light. As mentioned before, the focus of all these movements was the zenith itself, which seemed to be undergoing an intense bombardment of waves, ripples and searchlights from all sides, although subsidiary lateral movements were also in evidence.

Marvellous as was the rapidity of movement, the rapidity of change or kaleidoscopic effect was no less astonishing. Over and over again one of the observers would try to call attention to some particularly vivid display, only to find it utterly gone before the others could turn their eyes in the direction indicated. These changes were much more rapid than in other auroras seen by the writer. Nothing but electrical phenomena could approach their instantaneous shiftings.

At first the light was all pure white radiance, exactly that of electricity. Later certain areas took on a rose color, and still later the display more closely resembled that of ordinary auroras, being concentrated in the broad arch across the northern sky and showing more variety in colors.

So absorbed were the observers in this grand spectacle of light in motion that it was long before they noted the peculiar effect of the light upon themselves and their immediate surroundings. Then we saw that it was a perfectly diffused light, coming in practically equal intensity from all points of the sky. A more *unreal* scene could hardly be imagined. It was unlike moonlight, for there were no shadows nor shadings. On that account all objects seemed much less brilliantly illuminated than they really were. It was most like the light of early dawn; but still different, for in the dawn the light, although diffused, is all from one side. Objects were distinctly visible, but flat. Our companions' faces could be seen quite plainly, but lacked individuality. The opposite shore of the lake could be seen much more distinctly than in bright moonlight and objects inside the house were quite distinct, even if small.

How long the display lasted we do not know, although one of the party reported it as striking as ever well past midnight. Finally the chill of the night and the aching of our strained necks drove us indoors with the conviction that never again should we see such a stupendous spectacle of light in motion.

C. C. Nutting

State University of Iowa

INCREASING DEPTH OF FOCUS WITH THE SWING-BACK

To the Editor of Science: The writer admits his membership in the not inconsiderable class of field workers who are never satisfied with their photographic results. A little discovery, however, recently enabled him to improve the focus on certain classes of deep-focus pictures and he excuses the description

of a method of procedure which may be well known to photographers by the fact that it appears to be unknown to nearly all of the working geologists and zoologists with whom it has been discussed.

The utilization of the swing-back to eliminate distortion in the photographs of high buildings has long been known; the subject of this note is the application of the same method to increasing the depth of focus where both foreground and distance are desired, the swing-back being so manipulated as to increase the distance between the lens and the foreground portion of the photographic surface and to lessen the distance to the background portion of the same. The method is of course inapplicable where the objects in the foreground are high, and the element of distortion might bar it for some pictures, but useful applications of the method are many and will occur to all.

LANCASTER D. BURLING

OTTAWA, CANADA

SCIENTIFIC BOOKS

Grundlagen und Methoden der Paleogeographie. Fundamental Problems and Methods of Paleogeography. By DR. EDGAR DACQUÉ, Privatdozent an der Universität München. Gustav Fischer, Jena, 1915.

Dacqué's notable work is a comprehensive review of the literature of paleogeography and of the opinions of many geologists, representing German, Austrian, French, English, American, Swedish, Norwegian, Dutch and Italian thought, regarding the problems of the science. The list of authors cited comprises nearly five hundred names. The citations are so arranged that the views of any thinker on a specific problem are stated in appropriate context with those of others who may or may not agree with him. For the most part they are abstracts or interpretations, but Dacqué's presentation is accurate and impartial to a degree which may even seem lacking in discrimination, since speculations and respectable theories are treated with similar consideration. There is, however, a certain justification for this attitude, paleontology being in a very speculative stage of development and its problems being open to various tentative solutions. The work having been prepared for courses of lectures given at the University of Munich in 1912–13 and 1913–14 is marked by a didactic character. The advanced student will therefore find in this comprehensive review much that may seem elementary; he will also find much that is suggestive and helpful.

The chief value of the work for American readers lies in the numerous references to foreign writers and to views which are given more serious consideration by European geologists than they commonly are among Americans. In so far as American thought has been influenced by Chamberlin's far-reaching and fundamental studies, it has abandoned some theories to which Dacqué gives credit and has advanced to concepts which he does not discuss.

The introduction and the history of the literature of paleogeography for the past thirty-five years occupy the first forty pages of the work, and are followed by a discussion of the surface and structure of the earth. The statement includes the tetrahedral theory, as well as the disruption of the moon from the earth on the site of the Pacific Ocean, and closes with a consideration of the constitution of the earth on the assumption that the spheroid consists of a core of nickel iron separated from the known lithosphere by a zone of molten, yet rigid, magma, which allows horizontal displacements of the crust to occur. There is a certain parallelism with Barrel's hypothesis of an asthenosphere or zone of weakness, but German speculation suggests the possibility of horizontal movements of the outer crust far in excess of any that have been postulated by American investigators. Thus Dacqué discusses, as being within the range of credible hypothesis, wanderings of the pole amounting to twenty-five degrees of latitude and the even greater displacements of the continental masses postulated by Wegener.

Changes in the position of the pole might occur through absolute change in the position of the earth's entire mass with reference to the axis of rotation, or through relative move-

ment of an outer shell over the internal core, the latter retaining a constant orientation. Astronomical considerations are opposed to an absolute change in the position of the pole, at least during the eras of known geologic history, but they do not interfere with the possibility of a relative movement of an outer earth skin, either as a whole or in continental segments, provided there be no effective change in the position of the center of gravity of the spheroid. According to Wegener, whose speculations were published in the *Geologisches Rundschau* and in *Petermanns Mitteilungen* for 1912, the lighter continental masses, floating in denser material of the lithosphere, might move laterally. Postulating the sharp distinction of density and the plastic though resistant character of the substratum, which permits slow movements, there is, says Dacqué, no reason to deny that great horizontal displacements of the continental masses may occur, if only it can be shown that there are forces which, during prolonged geologic eras, have acted continuously in a constant direction. Finding such a force in deep-seated lateral stress due to the effort toward isostatic equilibruim, Dacqué concludes that we must hereafter take account of great relative crustal displacements with reference to the mass of the spheroid, regarding them, if not as facts, at least as sound working hypotheses.

It is not the purpose of the reviewer to discuss these concepts, but it may be observed that they may appear reasonable or extravagant according to one's previous education. We have learned to accept horizontal displacements of tens of miles. Overthrusts of this magnitude are clearly demonstrated. The generally accepted interpretation of Alpine structure has familiarized European geologists with the thought of much greater horizontal movements which are supposed to have resulted in piling slice upon slice of the superficial strata and basement rocks, far in excess of the ability of rocks to transmit crushing strains. Fifteen years ago Lugeon's extraordinary views were regarded as impossible. Now only a very small minority of his colleagues still opposes them, and the general agreement of the masters influences the younger generation of European geologists, schooled to accept an interpretation of mountain structure which contradicts the laws of mechanics and physics.

In a chapter on the rise and sinking of lands or changes of the oceanic level Dacqué reviews current theories of the causes of epeirogenic and orogenic movements, as they are represented in the writings of Suess, Wegener, Termier, Lachmann, Andrée, Haug, Daly, and others. The tendency is toward an abandonment of the contraction theory, the assignment of a minor rôle to isostatic adjustment in epeirogenic changes of level, and a return to the old plutonic or thermal hypothesis in some modified form, especially with reference to the subsidence of geosynclines and the subsequent folding and elevation of the accumulated sediments. Alpine studies again furnish the principal basis of European speculation, but there is also an appeal to English and American thought.

The permanence of oceanic basins is a theme which Dacqué discusses with a full appreciation of its importance in paleogeographic studies and of the diametrically opposite views held by various authorities. After a comprehensive review of marine transgressions and recessions over continental areas, he cites the arguments for and against permanence of the oceanic basins, and arrives at a sharp contradiction of evidence, which he proceeds to solve by adopting Wegener's suggestion of floating continents. It was Suess who designated the lighter rock masses, composed chiefly of silica-alumina rocks, as "Sal" and heavier ones, consisting of silica-magnesia materials, as "Sima." Assuming them to be differentiated, *sal* may be conceived to be a more or less continuous skin floating in *sima*, and it may be capable of disruption accompanied by separation of the parts. *Sima* forms the ocean bottoms and underlies the masses of *sal* which are the continents. The Pacific is a very ancient ocean basin; the Atlantic and Indian depressions are young. According to Wegener the Americas have become separated from Europe and Africa, and Dacqué finds therein the origin of the intervening deep. He says:

If in the ancient Pacific from long ago, that is from the opening of the Paleozoic on, the denser Sima lay exposed . . . and if that was the site of the permanent abyss, then has the dense material under the Atlantic and Indian oceans been exposed through displacement of the lighter salic continents, as if by the drawing back of a curtain, and the existing coincidence of the limits of density with the outlines of the continents and oceans is explained. The former invasions of the sea, which are shown to have spread over what are now land areas, are passing transgressions; the Pacific and the continents are permanent, aside from the displacements; the Atlantic and Indian oceans are younger deeps, floored with sima which appears at the surface in consequence of the displacements [of the continents]. Thus the problem of permanence is robbed of its contradictions and in essentials is explained.

The speculative section of the work, occupying 200 pages, thus presents some of the greater problems of geology as the introduction to paleography. Another and in the opinion of the reviewer a sounder method is to proceed from the facts of paleogeography toward the solution of those problems.

As a contribution to the science the latter half of Dacqué's work will seem to many the more valuable. In it are assembled the data of sedimentary formations considered as facts appropriate to paleogeographic investigation, estimates of absolute and relative durations of geologic time divisions, and examples of the construction of paleogeographic maps. The facts of stratigraphy and paleontology are admirably summarized, and the assemblage of illustrations constitutes a rich and suggestive reference for students of the subject.

Bailey Willis

Stanford University

Plant Life. By Charles A. Hall, F.R.M.S. The Macmillan Company, 66 Fifth Avenue, New York, N. Y. Cloth. Pp. 380. Eighty text-figures and seventy-four full-page illustrations. Price six dollars ($6.00).

Professor Hall has already written several books presenting various phases of nature-study in a popular way, so that experience in the field, in the laboratory and in the study have combined to make the present volume on "Plant Life" a useful addition to the series. It is addressed, principally, to the amateur botanist and lover of nature, but contains much which should be of interest to teachers of elementary classes.

The treatment follows the general evolutionary order from the lowest plants up to the highest. The excellent descriptions of field characters is an important feature of the work and should enable the beginner to find even the microscopic forms. Interesting bits of information and clever observations afford welcome material to those who wish to brighten their lectures and laboratory work.

The headings of the twelve chapters indicate not only the scope of the book, but also what might be expected in the mode of treatment. The headings are: Asexual Plants; The Development of Sex in Plants and a Study in Evolution; Seaweeds; Fungi and Lichens; Bryophytes—Liverworts and Mosses; Pteridophytes—Ferns, Horsetails and Club Mosses; Phanerogamia, Flowering Plants; Fossil Plants; The Food of Plants and How they Secure It; The Perpetuation of the Race; The Defences of Plants; Ecology; The New Field Botany. There is a general glossarial index.

The illustrations are excellent and most of them are new. In addition to eighty text-figures, there are seventy-four full-page illustrations, twenty-four being from photographs by the author and fifty in color from drawings by C. F. Newall. The binding and typography are in keeping with the high grade of the illustrations.

Charles J. Chamberlain

PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES

The eighth number of volume 2 of the *Proceedings of the National Academy of Sciences* contains the following articles:

1. *The Absorption Coefficients of Soft X-rays:* C. D. Miller, Ryerson Physical Laboratory, University of Chicago.

The numerical constants in the relation between the absorption coefficients, the density,

and the wave-lengths have been accurately determined. The results also indicate that the relationship holds for very much softer X-rays than those of ordinary penetrating power.

2. *Further Evidence as to the Relation between Crown Gall and Cancer:* Erwin F. Smith, Laboratory of Plant Pathology, United States Department of Agriculture.

There are discussed: Fundamental concepts, human and animal tumors for which no cause has been discovered, earlier discoveries in plants, further discoveries, other resemblances of crown gall to cancer in man and animals, possibility of the existence of carcinomas and of mixed tumors in plants, production of embryonal teratomata, and bearing of these discoveries on the cancer problem.

3. *Locomotion of Sea-Anemones:* G. H. Parker, Zoological Laboratory of the Museum of Comparative Zoology at Harvard College.

The pedal portion of a sea-anemone, like its tentacles, must contain a neuromuscular mechanism sufficient for the activity of that part of its body.

4. *The Behavior of Sea-Anemones:* G. H. Parker, Zoological Laboratory of the Museum of Comparative Zoology at Harvard College.

Sea-anemones are animals whose momentary conditions are dependent upon the combined stimuli of their immediate surroundings rather than forms that are greatly influenced by their past history, and their unity is not of a pronounced type; they are more in the nature of a sum of parts than they are organic units of the type of most of the higher animals.

5. *A Contribution to the Petrography of Japan:* J. P. Iddings and E. W. Morley, Brinklow, Maryland, and West Hartford, Connecticut.

Seventeen detailed chemical analyses are given of Japanese lavas.

6. *Is There a Temperature Coefficient for the Duration of Life?* Jacques Loeb and J. H. Northrup, Rockefeller Institute for Medical Research, New York.

In three series of experiments on the fruit fly *Drosophila*, it is found that the duration of life in the cases examined has a temperature coefficient of the order of magnitude which is characteristic for life phenomena and chemical reactions in general.

7. *On the Suggested Mutual Repulsion of Fraunhofer Lines:* Charles E. St. John, Mount Wilson Solar Observatory, Carnegie Institution of Washington.

The author is unable to find evidence of the mutual repulsion suggested and in so far as mutual influence is a necessary corollary of anomalous dispersion in the sun, evidence of this also is lacking.

8. *An Attempt to detect the Mutual Influence of Neighboring Lines in Electric Furnace Spectra showing Anomalous Dispersion:* Arthur S. King, Mount Wilson Solar Observatory, Carnegie Institution of Washington.

Although the material in the investigation is limited by the scarcity of suitable pairs of lines, the lines actually tested have shown no tendency toward a repulsion.

9. *Synthesis of the Base $C_8H_4ON_2$ derived from Methyl-Aminomethyl-3, 4-Dihydroxyphenyl-carbinol:* Chas. A. Rouiller, Pharmacological Laboratory, The Johns Hopkins University.

A continuation of some work by Abel with a suggestion as to a relation to work by Curtius.

10. *Extinguished and Resurgent Coral Reefs:* W. M. Davis, Department of Geology and Geography, Harvard University.

11. *The Origin of Certain Fiji Atolls:* W. M. Davis, Department of Geology and Geography, Harvard University.

The two papers offer a discussion of observations made during the author's Shaler Memorial voyage across the Pacific.

12. *Interferometer Methods based on the Cleavage of a Diffracted Ray:* C. Barus, Department of Physics, Brown University.

The prismatic method of cleaving the incident beam of white light is available for the superposition of non-reversed spectra, under

conditions where the paths of the component rays may have any length whatever. It is thus an essential extension of the same method as used for reserved spectra, heretofore, and also of the methods in which the paths are essentially small.

13. *On the Inheritance of Certain Glume Characters in the Cross Avena Fatua XA. Sativa Var. Kherson:* FRANK M. SURFACE, Biological Laboratory, Maine Agricultural Experiment Station.

A study of inheritance of certain characters particularly directed toward revealing phenomena of linkage.

14. *A Comparison of the Rates of Regeneration from Old and from New Tissue:* CHARLES ZELENY, Zoological Laboratory, University of Illinois.

The data as a whole show clearly that there is no essential difference between the rate of regeneration from new cells and from old cells. The rate of regeneration seems therefore to be under central control.

15. *The Effect of Successive Removal upon the Rate of Regeneration:* CHARLES ZELENY, Zoological Laboratory, University of Illinois.

Apart from the slowing due to age there is no indication of the amount of new material that may be produced by regeneration. The actual limitation comes not from the using up of regenerative energy, but from changes in the non-regenerating part associated with age.

16. *The Geologic Rôle of Phosphorus:* ELIOT BLACKWELDER, Department of Geology, University of Wisconsin.

Phosphorus appears in nature in many forms and in many situations. Its numerous transformations, however, follow an orderly sequence—in a broad way form a cycle—which is here discussed in some detail.

17. *Dominantly Fluviatile Origin under Seasonal Rainfall of the Old Red Sandstone:* JOSEPH BARRELL, Department of Geology, Yale University.

Geologists have differed so widely in their conclusions in regard to the nature of the habitat of the early vertebrate faunas whose remains are found in the formations of the Old Red Sandstone, that the author is led to examine critically the criteria for the interpretation of the facts. He comes to the conclusion that the deposits which make up the Old Red Sandstone, although they undoubtedly contain lacustrine beds and other beds laid down in shifting, shallow and variable bodies of water, are dominantly fluviatile in origin. The Great Valley in California may therefore in the present epoch, both in physiography and in climate, be cited as a striking illustration of the nature of the Old Red Sandstone basins.

18. *The Influence of Silurian-Devonian Climates on the Rise of Air-Breathing Vertebrates:* JOSEPH BARRELL, Department of Geology, Yale University.

The evidence for the hypothesis of the continental origin of fishes has been examined and seems to prevail over that for their marine origin. The author also believes that natural selection, although discredited as a cause determining specific variations, appears nevertheless to be a major factor in evolution.

19. *Density of Radio-Lead from pure Norwegian Cleveite:* T. W. RICHARDS AND C. WADSWORTH, 3D, Wolcott Gibbs Memorial Laboratory, Harvard University.

The density of this lead is found to be 11.273, distinctly less than the density (11.289) of Australian radio-lead and still less than that (11.337) for ordinary lead, the decrease being almost exactly proportional to the decrease in atomic weight in these samples, so that the atomic volume (18.281) is constant.

20. *National Research Council.*

A preliminary report to the president of the academy by the organizing committee recently printed in full in SCIENCE.

EDWIN BIDWELL WILSON
MASS. INSTITUTE OF TECHNOLOGY,
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SPECIAL ARTICLES

IMBIBITIONAL SWELLING OF PLANTS AND COLLOIDAL MIXTURES

THE swelling of gelatine in distilled water, alkali and acid has long been used as refer-

ence phenomena in interpreting the water relations of plants especially in growth, and some conclusions founded on the assumption that growing organs, like gelatine, would show a maximum swelling in acidified solutions are shown by our work to be mistaken ones.

During the course of some comprehensive studies on growth now being carried out at the Desert Laboratory it was deemed desirable to follow the entire course of development of shoots of *Opuntia,* and to make chemical analyses at various stages. Growth depends so largely upon the capacity for absorption and retention of water that numerous measurements of the swelling capacity of developing and mature members were made.

The method consisted in cutting clean disks 12 mm. across from the flattened joints of *Opuntia.* Three of these were arranged in the bottom of a Stender dish and a triangle of thin sheet glass arranged to rest its apices on the three disks. The vertical swinging arm of an auxograph[1] was now adjusted to a shallow socket in the center of the glass triangle while the pen was set at zero on the recording sheet. Water or a solution being poured into the dish, the course of the swelling was traced.

That the amount of imbibition depended mainly upon the presence of certain recognizable substances and not upon properties of the disks as masses of living material was demonstrated by the fact that dried disks gave proportionate differences equivalent to those of living material.

The average thickness of disks varied from 4 or 5 mm. in the case of young joints to 18 or 20 mm. in mature ones. The apical parts of joints showed greater capacity for absorption than the basal ones in the proportion of 21 or 22 to 16 or 17 per cent. Comparative tests were finally based on disks taken from apical regions. The capacity for absorbing water was seen to increase up to maturity (about 1 year old) then to decrease as illustrated by the following set of tests with *Opuntia blakeana* made May 17–29, 1916.

Opuntia blakeana	Young	Mature	Old
Swelling (distilled water) ..	24.3%	50%	41.3%

The amount of imbibition does not appear as a continuous function of any one substance or group of substances, the presence and amount of which were estimated. This would harmonize with the results of swelling mixtures of gelatine and agar described below. The phenomena of proportionate swelling of gelatine in water, acids, alkalies and salt solutions have been mistakenly used hitherto in attempts at explanation of the mechanism of growth. It has been demonstrated by repeated tests that the tracts of growing cells studied, as well as maturing or mature tissues, do not swell more in acid than in distilled water or alkali, as will be illustrated by the following results taken at random from numerous records obtained at Tucson.

SWELLING OF DISKS OF OPUNTIA

	Dist. Water	Sodium Hydrate (Hundredth Normal)	Hydrochloric Acid (Hundreth Normal)
Young.......	23.6 %	22.9%	16.4%
Mature......	40%	52.1%	36.6%

It is conclusively established that both young and old tissues take up more water when neutral or alkaline. Acidity therefore in addition to retarding enzymatic action presumably including respiration would operate to lessen growth by its effects in decreasing imbibition by plant tissues.

It being demonstrated that growing masses of embryonic cells in plants and tracts of mature tissue show their greatest capacity for the imbibition of water not in acidified but in alkaline solutions, it was sought to find what substance or mixture of substances would behave in a similar manner. The first inquiry was made with agar which is composed of pentoses presumably having some qualities identical with those of the mucilages of the plant. Dried cylinders and sheets of this material were first subjected to the tests, being placed under the auxograph after the manner in which disks of living material were treated as described in a

[1] See MacDougal, D. T., "Mechanism and Conditions of Growth," *Mem. N. Y. Bot. Garden,* 6: p. 14, 1916.

previous paragraph. The results compared with the swelling of gelatine were as follows:

	Sodium Hydrate (Hundredth Normal)	Hydrochloric Acid (Hundredth Normal)	Water
Swelling of agar......	124%	113%	197%
Swelling of gelatine..	250%	382%	83%

As the plant did not show water relations which might be interpreted as a mechanical resultant of the separate action of gelatine or agar it was next proposed to test the reactions of a mixture in which these substances would be blended, which was done in July, 1916. The first test mass was one consisting of about equal parts of agar and gelatine, though the quantities were not weighed. Both were soaked and melted separately and the gelatine was poured into the hot agar which was kept at a temperature of about 90° C. for a half hour. The mass was then poured on to a glass slab for cooling. Two days later it was stripped off as a fairly clear and transparent sheet slightly clouded, the average thickness of which was 0.2 mm. Strips about 5 × 7 mm. were placed under the apices of sheet glass triangles in glass dishes after the manner in which plant sections had been tested, and auxographs were arranged to record the action of acids, alkalies and distilled water. The first trial made on July 21 gave the following final relative size of the strips as compared with the original: distilled water 850 per cent.; nitric acid (hundredth normal), 725 per cent.; hydrochloric acid (hundredth normal), 750 per cent.; sodium hydrate (hundredth normal), 950 per cent. No record of the temperature of the room was kept. A second test on the following day at temperatures of 61°–65° F. gave the following: distilled water, 675 per cent.; hydrochloric acid, 625 per cent.; nitric acid, 687.5 per cent.; sodium hydrate, 750 per cent. These results were taken to be of such importance that a series of mixtures of agar with 20, 50 and 80, 95 and 99 per cent. of gelatine by dry weight were made up. The mixtures were poured into moulds on glass plates and dried sheets from 0.1 mm. to 0.6 mm. in thickness were obtained. The measurements given below include the results of tests under varied conditions not only of thickness of the samples, but also of temperature, length of period of swelling, tension of instruments, etc. Each set of three measurements of the swelling in the three liquids is therefore to be considered separately, and is not to be compared with one above or below, either as to amplitude or relative swelling, as the experiments were varied in many ways. For the sake of completeness some results with agar and with gelatine alone are included.

Sodium Hydrate (Hundredth Normal)	Hydrochloric Acid (Hundreth Normal)	Distilled Water
	Gelatine	
280%	560%	250%
125	283	125
	Gelatine 100—Agar 1	
750	1,100	520
	Gelatine 100—Agar 5	
667	767	325
704	933	333
	Gelatine 80—Agar 20	
800	700	425
875	775	—
600	900	—
850	650	558
600	600	275
900	1,000	600
700	900	300
	Gelatine 50—Agar 50	
788	788	692
500	333	1,133
600	350	525
675	225	—
400	350	500
600	200	700
450	300	875
633	367	1,167
	Gelatine 20—Agar 80	
600	400	1,150
600	600	1,450
600	700	1,200
450	700	1,150
433	533	767
600	500	1,200
	Agar	
400	650	775
525	800	1,100

The outstanding fact that a mixture consisting mostly of gelatine, to which a small proportion of agar has been added, shows its greatest swelling in alkaline solutions is the most important feature of these results. The mixture in question is available as a physical analogue which has already been found useful in the study of growth and swelling of plants.

The data of the table indicate that as the percentage of agar in the gelatine is increased the mixture swells more in distilled water and less in acid or alkali, thus approaching the behavior of pure agar. Concerning the relative effects of acid and alkali, assured conclusions are not now possible but the data suggest that acid tends to increase imbibition at the ends of the series, that is as pure agar and pure gelatine are approached, while alkali tends to increase it in the middle mixtures containing the two colloids in more nearly equal proportions. D. T. MACDOUGAL

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THE THEORY OF AUTONOMOUS FOLDING IN EMBRYOGENESIS[1]

THE experiments of Roux,[2] carried out on the embryonic chick, prove conclusively that the folding of a neural plate into a neural tube is not dependent, as His[3] had supposed, on the mechanical effect of one tissue upon another, but is autonomous. Self-differentiation in this instance is identical with self-folding. The question therefore arises: How can the neural plate fold itself?

Our reply must necessarily bear on all cases of autonomous folding, and reciprocally any one of them might serve as the basis for this analysis. The nervous system, however, is by far the largest, most easily studied, and, in addition, the most familiar of all the embryonic tissues in which self-folding occurs. Moreover, in its simpler forms, it indicates so clearly the direction in which an explanation of its autonomous transformations is to be sought, that for the present it seems best to limit the discussion to what may be justified as a type case.

[1] Read at the joint meeting of the American Society of Zoologists and Section F of the American Association for the Advancement of Science, in Columbus, December, 1915.

[2] "Die Entwicklungsmechanik," W. Engelmann, Heft 1, Leipzig, 1905.

[3] "Unsere Körperform, und das Physiologische Problem Ihrer Entstehung," F. C. W. Vogel, Leipzig, 1874.

For our immediate purposes, the neural plate of *Cryptobranchus allegheniensis* is especially suitable. Not only is it unusually large, as neural plates go, but wherever cell-boundaries are distinct, it is, without question, unicellular in thickness. The first problem to be solved is the rôle of cell-multiplication.

In a neural plate in which the cells are irregular in position and dovetailed into one another as they are in crowded columnar epithelia, inequalities in the rate of division and protoplasmic synthesis at or near the two surfaces might lead to folding, but in the *Cryptobranchus* embryo, in which the plate is partly syncytial and in which the visible cell-walls are continuous from one surface to the other, and remain so during the entire period of folding, it is difficult to conceive how cell-multiplication could result in anything except uniform enlargement. The exclusion of this factor from participation in the process of involution, however, does not depend on mere argumentation, for comparison of the number of nuclei in comparable regions of the flat, half-folded, and completely folded plate, shows that the number of cells per section actually does not increase[4] (Table I.). Indeed in less

TABLE I

Number of Nuclei in Comparable Sections

Stage I, Flat	Stage II, Half-folded	Stage III, Folded
63	56	55
53	64	60
58	50	73
69	56	47
72	50	69
58	82	59
59	70	64
58	74	51
58	58	52
68	51	55
Ave. 62	61	59

simple material, such as the neural plate of the mammal, in which the number of cells does increase during folding, the restriction of the mitoses to the concave surface must, if effective at all, exert a force opposed to the forces that bring about the curvature. In this instance,

[4] For the validity of these comparisons see Glaser, *Anatomical Record*, Vol. 8, pp. 528–530.

therefore, a neural plate folds *in spite of* an increase in the number of its constituent cells.

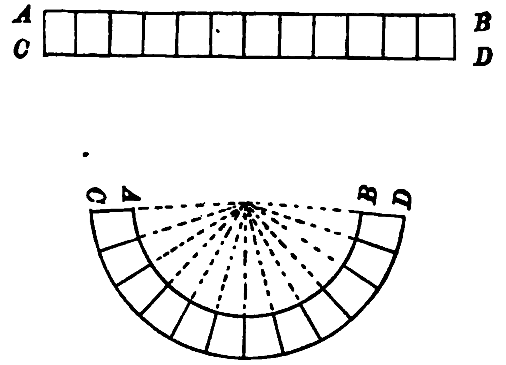

Fig. 1. Diagrammatic representation of a neural plate *A B C D*, conceived of, for the sake of simplicity, as entirely flat and made up of one layer of rectangular cells. The lower half of the figure shows the same plate symmetrically folded, its upper and under sides having become the outlines of two concentric circles. With the cells constant in number and position, the line *A B* is now necessarily shorter than the line *C D*.

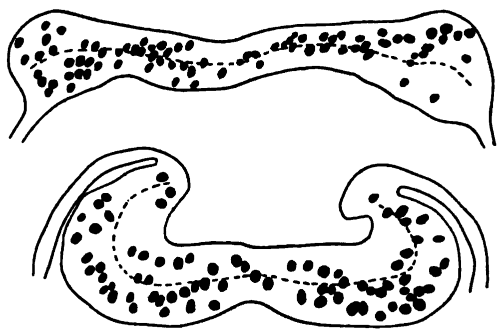

Fig. 2. Two sections through the embryonic nervous system of *Cryptobranchus alleghenienis*, showing the nuclear distribution in Stages I. and II. The sections are from the same series and regions as those dealt with in the tables but contain for Stage I., six, and for Stage II., one nucleus more than the maximal number recorded in Table I. In the unfolded plate there are in the present case, 78 nuclei, of which 47 are in the upper half above the dotted line, and 31 in the lower; in the half-folded plate, there are 75 nuclei, 21 in the upper zone, and 54 in the lower. Nuclei which happen to fall on the line separating the two zones are ascribed to the one into which the greater portion of their mass projects.

The only remaining way in which a neural plate can fold itself is by a rearrangement of materials present at the beginning. In this connection the most patent fact, emphasized long ago by Rhumbler[5] and Conklin[6] in their studies of invaginate gastrulation, is a change in the shape of the cells whose sectional outlines alter from the rectangular form to that of a trapezium (Fig. 1). This geometrical transformation, which might be forced upon the cells from without, necessarily has the same result when autonomously produced, for it involves lengthening of one surface, shortening of the other, and a redistribution of the cell-contents. The extent of the latter, as indicated by the migration of nuclei from the side becoming concave to that becoming convex, is clearly shown for two sections in Fig. 2, and for a series, in Table II.

TABLE II

Distribution of Nuclei in Upper and Lower and Inner and Outer Zones

Stage I, Flat		Stage II. Half-folded		Stage III, Folded	
Upper	Lower	Upper	Lower	Inner	Outer
32	31	31	25	15	40
32	21	22	42	15	45
34	24	16	34	21	52
55	14	27	29	13	34
39	33	18	32	22	47
38	20	27	55	16	43
31	28	33	37	26	38
33	25	29	45	13	38
37	21	21	37	20	32
44	24	19	32	20	35
Ave. 38	24	24	37	18	39

According to this, the distribution of the nuclei is not only completely reversed during folding, but the final relation between the number in what become the inner and outer zones, respectively, of the definitive tube, is as 2 to 1. Provided only that the nervous system is, by its structure and relations, incapable of indefinite expansion, these changes are all that are required to bring about the folding.

5 "Zur Mechanik des Gastrulationsvorganges," *Arch. f. Entwicklungsmech.*, Bd. 14.

6 "Mosaic Development in Ascidian Eggs," *Jour. Exp. Zool.*, Vol. 2, p. 163.

In my attempt to gain some insight into the manner in which these changes might be effected in the absence of coercion from without, I determined, at constant magnification, the areas of comparable sections during the process of involution. The marked relative increases shown in Table III. were found.[7]

TABLE III

Relative Areas of Comparable Sections

Stage I, Flat	Stage II, Half-folded	Stage III, Folded
9.4 cm.[2]	13.7 cm.[2]	17.5 cm.[2]
8.1	11.3	19.5
10.6	11.4	19.5
9.9	10.1	20.6
9.1	10.1	20.5
9.6	10.9	18.1
9.1	11.5	19.0
8.2	12.0	18.5
8.3	10.2	18.9
9.9	10.1	18.8
Ave. 9.2	11.1	19.1

This increase in area indicates growth in volume, and can be the result only of enlargement on the part of the individual cells constituting the nervous system. The immediate problem is obvious.

In Table IV. are given the water-content as well as the distribution of water in the larvæ of *Rana pipiens* and *Amblystoma punctatum*, four to five days after fertilization.

Since the period of differentiation under discussion has been completed at the stage of development considered in the table, and since this differentiation includes folding, and folding is associated with enlargement, it follows that the differential absorption of water by the nervous system probably took place during the process of involution. As the results show, the water-content rises to a point practically identical with the figure 80.5 per cent. given by Donaldson for the cord of the adult *R. pipiens.*[8]

[7] For details concerning the distribution of this increase within the sections themselves, see Glaser, *loc. cit.*, pp. 530–533.

[8] Donaldson, Henry H., "Further Observations on the Nervous System of the American Leopard Frog, etc.," *Jour. Comp. Neurol.*, Vol. 20. Also earlier papers.

TABLE IV

Water Content and Distribution of Water in Embryos of Rana pipiens and Amblystoma punctatum Four to Five Days after Fertilisation

Material	Fresh Weight, Grams	Dry Weight, Grams	Dry Substance, Per Cent.	Water, Per Cent.
R. pipi·ns:				
38 larvæ	0.1278	0.0557	43.6	56.4
50 larvæ	0.1718	0.0722	42.0	58.0
39 larvæ	0.1815	0.0730	40.2	59.8
41 larvæ	0.1788	0.0733	41.0	59.0
Average			**41.7**	**58.3**
24 yolk-sacs	0.0140	0.0204	46.5	53.5
31 yolk-sacs	0.0585	0.0264	45.1	54.9
Average			**45.8**	**54.2**
24 nervous systems	0.0464	0.0098	21.1	78.9
31 nervous systems	0.0714	0.0149	20.9	79.1
50 nervous systems	0.0916	0.0185	20.2	79.8
Average			**20.7**	**79.2**
A. punctatum:				
16 larvæ	0.0955	0.0399	41.8	58.2
15 larvæ	0.0992	0.0406	40.9	59.1
Average			**41.4**	**58.6**
125 nervous systems	0.3914	0.0785	19.9	80.1
52 nervous systems	0.1756	0.0400	22.8	77.2
15 nervous systems	0.0524	0.0106	20.2	79.8
69 nervous systems	0.2039	0.0363	17.8	82.2
Average			**20.2**	**79.8**

But this absorption of water can only account for the enlargement of the nervous system, not at all for its folding.

To explain this in complete harmony with all the known facts, only one assumption is necessary. The neural plate is exposed to an external environment, whose constancy, within the limits under which normal development takes place at all, is very high. Laterally each cell of the plate is bounded by a chemical system fundamentally like itself. Disturbances of equilibrium on any one of these surfaces are relatively unlikely. However, on its under side, the plate is subjected to a constant change of conditions due to the multitude of processes going on within the rest of the embryo. To mention only one factor, there is a distinct increase in the acidity of the internal medium.

On this basis we may interpret the absorp-

tion of water as the result of a change in those surfaces of the absorbent cells which are exposed to the inconstant intra-embryonic environment. If this change involves a weakening of the face of the neural plate that becomes convex, the curvature that leads to the formation of a tube would be accounted for.[9]

Accordingly then, the absorption of water is not the cause of folding, but a symptom of that cause. If this interpretation is correct, the water content of the cells at any given level in the early stages of involution can not be uniform. In fact the theory demands that the marginal cells of the neural plate, the first, it will be recalled, to undergo a change of shape, shall have a higher water-content than the cells in the middle of the plate which only assume the wedge-shape during the last stages of involution.

For the decision of this crucial question, no direct method is as yet available. However, it is possible to secure evidence indirectly which seems to me convincing.

If the eggs of the starfish are placed in hypotonic sea-water, and given an opportunity to absorb more water than they normally contain, they at once increase in volume, and their nuclei, easy to deal with on account of their spherical shape, also enlarge. The facts on which this statement is based are given in Table V.

TABLE V

Asterias Eggs in Various Concentrations of Sea-water

No. of Eggs	Conc. Sea Water	Conc. Dist. Water	Diam. Eggs	Diam. Nuclei
18	100%	0%	142μ	.68μ
	66	34	170	.82
23	100	0	138	.66
	75	25	144	.70
47	100	0	152	.66
	60	40	188	.82
49	100	0	154	.66
	60	40	170	.80

[9] For the relation between this view and the Rhumbler Surface-Tension Hypothesis, as well as for a criticism of the latter, see Glaser, *loc. cit.*, pp. 536–548.

Before applying this information to the problem in hand, I had first of all to determine whether these facts held for the nervous system, and especially whether measurable differences could be demonstrated in those regions known to have contained during life, different proportions of water.[10]

TABLE VI

Relative Water Contents of Embryonic Cords and Brains

	Embryonic Cords		Embryonic Brains
Amblystoma	125	>	125 by 2.2 per cent.
Rana	139	>	135 by 1.9 per cent.
Rana	192	>	188 by 2.3 per cent.

Relative Sizes of Nuclei

Nervous System of *Cryptobranchus Embryos*

Stage I			Stage II			Stage III		
Cord	Brain	Ratio	Cord	Brain	Ratio	Cord	Brain	Ratio
109	109	1:1.2	126	114	1:1.1	125	113	1:1.1
119	114	1:1.2	107	108	1:1.1	143	123	1:1.1
120	125	1:1.1	127	129	1:1.2	133	113	1:1.1
121	119	1:1.1				115	131	1:1.1

Control 36-hour Chick

End of Cord	Forebrain	Ratio
110	124	1:1.4

Relative Sizes of Nuclei in Center and at Edges of Neural Plate in Cryptobranchus during Folding

Number and Positions of Nuclei

Central	Lateral	Ratio
110	115	1:1.2
112	120	1:1.2
112	111	1:1.1
135	122	1:1.2

In both *Amblystoma punctatum* and *Rana pipiens* (Table VI.), a comparison of the anterior and posterior ends of the embryonic nervous systems, indicates a higher water-content in the larval brain than in the cord. Since these results are consistent, and, in sense, agree with corresponding differences found by Donaldson (*loc. cit.*) for the adult nervous system of *Rana pipiens*, I feel fairly certain of the essential correctness of my values, and

[10] That the embryonic brain has a higher water content than the cord is indicated by the figures which I published in SCIENCE, N. S., Vol. XXXIX., pp. 730–731, in 1914. The evidence there presented was meager and, unfortunately, I overlooked some arithmetical errors. Recalculation has made no essential difference in the results, however, and further evidence now shows them to have been essentially correct.

infer, therefore, that the embryonic brain, like that of the adult, also has a water-content higher than that of the cord at the same age.

If this is indeed correct, and, moreover, if nuclear volume varies with the water-content of the cell, and, furthermore, if fixation does not destroy or completely reverse the volumetric relations, one would expect the nuclei in the anterior end of an embryonic nervous system to be larger than those in the posterior.

In *Cryptobranchus* embryos such comparisons are easily made. The nuclei are large so that errors, inevitably committed in determining their volumes, are relatively small. Certain precautions however are essential. Thus nuclei in various stages of mitosis must obviously be excluded. Also, since the resting nucleus is ovoid in shape, it is necessary to consider only those similarly oriented with reference to the plane of section. Absolute volumes are, of course, not practicable, nor are they requisite. All that the theory demands is that the average size of the nuclear sections in the regions which had the higher water-content shall be greater than those in the regions in which the water-content was lower. Tracings of some 2,800 nuclei whose outlines on paper were cut out with scissors and weighed under uniform conditions of atmospheric moisture, give results remarkable for their uniformity.

The absolute regularity of the ratios based on *Cryptobranchus*, and on the control observation on the thirty-six hour chick, convinced me that nuclear size, even in preserved materials, can be utilized as an index of original water-content. If now, the absorption of water is itself an index to the surface alteration to which I attribute the change in shape undergone by the cells during involution, then the nuclei of the lateral curling edges in any given section should on the average be larger than those in the, as yet, unfolded center. This, as indicated in the last division of Table VI., is true for *Cryptobranchus*.

Since this expectation has been fulfilled, I feel that the problems involved in the autonomous folding of the nervous system, and by implication, also involved in such other autonomous foldings as that of the entodermal plate in typical invaginate gastrulation, have begun to merge with the physical-chemistry of the tissues concerned, and the conditions to which their constituent cells are subjected at various periods of development.

O. C. Glaser

University of Michigan

SOCIETIES AND ACADEMIES

THE AMERICAN MATHEMATICAL SOCIETY

The twenty-third summer meeting and eighth colloquium of the society were held at Harvard University during the week September 4–8, 1916. Monday and Tuesday were devoted to the summer meeting proper, two sessions being held on each day for the presentation and discussion of papers. The colloquium opened on Wednesday morning and extended to Friday afternoon. Courses of lectures were given by Professor G. C. Evans, of Rice Institute, on "Topics from the theory and applications of functionals, including integral equations," and Professor Oswald Veblen, of Princeton University, on "Analysis situs."

Ninety-nine were in attendance. President E. W. Brown occupied the chair, being relieved by Vice-presidents E. R. Hedrick and Virgil Snyder. The council announced the election of the following persons to membership in the society: Mr. Herman Betz, Cornell University; Mr. J. A. Bigbee, High School, Little Rock, Ark.; Mr. Hillel Halperin, Vanderbilt University; Dr. J. R. Kline, University of Pennsylvania; Professor J. J. Luck, University of Virginia; Dr. F. J. McMackin, Dartmouth College. Seven applications for membership in the society were received.

Through the generosity of Harvard University the freshman dormitories and dining room were thrown open for the use of the society during the meeting. On Monday noon the members were shown the collection of mathematical models belonging to the university. On Wednesday afternoon a visit was paid to the university library, and on Wednesday evening to the observatory. Resolutions were adopted at the meeting expressing the thanks of the society for the hospitality of the university and its officers.

Fraternal greetings were exchanged by cable with the Scandinavian mathematicians assembled at Stockholm. A vote of congratulation was tendered to the secretary on his twenty-first year of service in that capacity.

The twenty-fifth anniversary of the broadening out of the society into a national organization and the founding of the *Bulletin* were celebrated at the banquet on Monday evening, at which eighty-four members and friends were present. Brief addresses were made by Professors Fiske, W. W. Johnson, Fine, Birkhoff, Hedrick, Webster, Coolidge and the secretary.

On Tuesday evening Professor D. E. Smith entertained the society with an interesting account of "The relation of the history of economics to the history of arithmetic problems."

The following papers were read at the summer meeting:

J. C. Fields: "Direct derivation of the complementary theorem."

C. A. Fischer: "Note on the order of continuity of functions of lines."

Olive C. Hazlett: "On the theory of associative division algebras."

W. C. Eells: "A statistical study of eminent mathematicians."

J. L. Coolidge: "The characteristic numbers of real algebraic plane curves."

R. W. Burgess: "The comparison of a certain case of the elastic curve with its approximation."

G. A. Miller: "Orders of operators of congruence groups modulo $2^r 3^s$."

John Eiesland: "Sphere geometry (third paper)."

A. J. Kempner: "Generalization of a theorem on transcendental numbers."

C. N. Moore: "On the developments in Bessel's functions."

Arnold Dresden: "Supplementary note on the second derivatives of an extremal integral."

L. E. Dickson: "Extension of the theory of numbers to the rational numbers of certain sets."

A. G. Webster: "On a theory of acoustic horns."

E. H. Moore: "On properly positive Hermitian matrices."

L. P. Eisenhart: "Deformations of transformations of Ribaucour."

F. R. Sharpe and Virgil Snyder: "On $(2-2)$ point correspondence between two planes."

F. H. Safford: "Surfaces of revolution in the theory of Lamé's products."

Dunham Jackson: "Note on the parametric representation of an arbitrary continuous curve."

Dunham Jackson: "Note on representations of the partial sum of a Fourier series."

L. H. Rice: "Determinants of many dimensions."

L. R. Ford: "Regular continued fractions."

M. W. Haskell: "The eliminant of a system of forms."

E. V. Huntington: "A simple substitute for Duhamel's theorem."

E. V. Huntington and J. R. Kline: "Sets of independent postulates for betweenness."

G. D. Birkhoff: "Dynamical systems with two degrees of freedom (second paper)."

E. B. Van Vleck: "Non-loxodromic substitutions in n variables."

L. I. Hewes: "Nomograms of adjustment."

H. C. M. Morse: "A theorem on the linear dependence of analytic functions of a single variable."

G. A. Pfeiffer: "Note on the linear dependence of analytic functions."

G. M. Green: "On the linear dependence of functions of one variable."

C. L. Bouton: "Iteration and group theory."

G. M. Green: "On the general theory of surfaces."

W. V. Garretson: "On the asymptotic solution of the non-homogenous linear differential equation of the nth order. A particular solution."

Caroline E. Seely: "On series of biorthogonal functions."

A. B. Frizell: "Lemma for a new method of generating alephs."

John Eiesland: "Transformation theory of the flat complex and its associated line complex."

A. R. Schweitzer: "On the type of quasi-transitive functional equations (second paper)."

A. R. Schweitzer: "A problem in quasi-transitive functional equations."

A. R. Schweitzer: "Some theorems on quasi-transitive functional equations."

A. R. Schweitzer: "On the analogy between functional equations and geometric order relations."

T. H. Gronwall: "On the power series for $\log (1+z)$."

T. H. Gronwall: "A problem in geometry connected with the analytic continuation of a power series."

T. H. Gronwall: "On the convergence of Binet's factorial series for $\log \Gamma(z)$ and $\psi(z)$."

T. H. Gronwall: "On the zeroes of the function $\beta(z)$ associated with the gamma function."

The next meeting of the society will be held at Columbia University on Saturday, October 28. The Southwestern Section will meet at the University of Kansas on Saturday, December 2.

F. N. COLE,
Secretary

SCIENCE

Friday, October 13, 1916

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

THE RELATION OF PURE SCIENCE TO INDUSTRIAL RESEARCH[1]

It is not strange that many years ago Huxley, with his remarkable precision of thought and his admirable command of language, should have indicated his dissatisfaction with the terms "pure science" and "applied science," pointing out at the same time that what people call "applied science" is nothing but the application of pure science to particular classes of problems. The terms are still employed, possibly because, after all, they may be the best ones to use, or perhaps our ideas, to which these expressions are supposed to conform, have not yet become sufficiently definite to have called forth the right words.

It is not the purpose of this address, however, to suggest better words or expressions, but rather to direct attention to certain important relations between purely scientific research and industrial scientific research which are not yet sufficiently understood.

Because of the stupendous upheaval of the European war with its startling agencies of destruction—the product of both science and the industries—and because of the deplorable unpreparedness of our own country to defend itself against attack, there has begun a great awakening of our people. By bringing to their minds the brilliant achievements of the membership of this institute in electric lighting and power and communications and by calling their attention to the manifold

[1] President's address given at the thirty-third annual convention of the American Institute of Electrical Engineers.

achievements of the members of our sister societies in mechanical and mining and civil engineering, and the accomplishments of our fellow-workers, the industrial chemists, they are being aroused to the vital importance of the products of science in the national defense.

Arising out of this agitation comes a growing appreciation of the importance of industrial scientific research, not only as an aid to military defense but as an essential part of every industry in time of peace.

Industrial research, conducted in accordance with the principles of science, is no new thing in America. The department which is under my charge, founded nearly forty years ago to develop, with the aid of scientific men, the telephone art, has grown from small beginnings with but a few workers to a great institution employing hundreds of scientists and engineers, and it is generally acknowledged that it is largely owing to the industrial research thus conducted that the telephone achievements and developments in America have so greatly exceeded those of other countries.

With the development of electric lighting and electric power and electric traction which came after the invention of the telephone, industrial scientific research laboratories were founded by some of the larger electrical manufacturing concerns and these have attained a world-wide reputation. While vast sums are spent annually upon industrial research in these laboratories, I can say with authority that they return to the industries each year improvements in the art which, taken all together, have a value many times greater than the total cost of their production. Money expended in properly directed industrial research, conducted on scientific principles, is sure to bring to the industries a most generous return.

While many concerns in America now have well organized industrial research laboratories, particularly those engaged in metallurgy and dependent upon chemical processes, the manufacturers of our country as a whole have not yet learned of the benefits of industrial scientific research and how to avail themselves of it.

I consider that it is the high duty of our institute and of every member composing it, and that a similar duty rests upon all other engineering and scientific bodies in America, to impress upon the manufacturers of the United States the wonderful possibilities of economies in their processes and improvements in their products which are opened up by the discoveries in science. The way to realize these possibilities is through the medium of industrial research conducted in accordance with scientific principles. Once it is made clear to our manufacturers that industrial research pays, they will be sure to call to their aid men of scientific training to investigate their technical problems and to improve their processes. Those who are the first to avail themselves of the benefits of industrial research will obtain such a lead over their competitors that we may look forward to the time when the advantages of industrial research will be recognized by all.

Industrial scientific research departments can reach their highest development in those concerns doing the largest amount of business. While instances are not wanting where the large growth of the institution is the direct result of the care which is bestowed upon industrial research at a time when it was but a small concern, nevertheless conditions to-day are such that without cooperation among themselves the small concerns can not have the full benefits of industrial research, for no one among them is sufficiently strong to maintain the necessary staff and laboratories. Once the vital importance of this subject is appre-

ciated by the small manufacturers many solutions of the problem will promptly appear. One of these is for the manufacturer to take his problem to one of the industrial research laboratories already established for the purpose of serving those who can not afford a laboratory of their own. Other manufacturers doing the same, the financial encouragement received would enable the laboratories to extend and improve their facilities so that each of the small manufacturers who patronizes them would in course of time have the benefit of an institution similar to those maintained by our largest industrial concerns.

Thus, in accordance with the law of supply and demand, the small manufacturer may obtain the benefits of industrial research in the highest degree and the burden upon each manufacturer would be only in accordance with the use he made of it, and the entire cost of the laboratories would thus be borne by the industries as a whole, where the charge properly belongs. Many other projects are now being considered for the establishment of industrial research laboratories for those concerns which can not afford laboratories of their own, and in some of these cases the possible relation of these laboratories to our technical and engineering schools is being earnestly studied.

Until the manufacturers themselves are aroused to the necessity of action in the matter of industrial research there is no plan which can be devised that will result in the general establishment of research laboratories for the industries. But once their need is felt and their value appreciated and the demand for research facilities is put forth by the manufacturers themselves, research laboratories will spring up in all our great centers of industrial activity. Their number and character and size, and their method of operation and their relation to the technical and engineering schools, and the method of their working with the different industries, are all matters which involve many interesting problems—problems which I am sure will be solved as they present themselves and when their nature has been clearly apprehended.

In the present state of the world's development there is nothing which can do more to advance American industries than the adoption by our manufacturers generally of industrial research conducted on scientific principles. I am sure that if they can be made to appreciate the force of this statement, our manufacturers will rise to the occasion with all that energy and enterprise so characteristic of America.

So much has already been said and so much remains to be said urging upon us the importance of scientific research conducted for the sake of utility and for increasing the convenience and comfort of mankind, that there is danger of losing sight of another form of research which has for its primary object none of these things. I refer to pure scientific research.

In the minds of many there is confusion between industrial scientific research and this purely scientific research, particularly as the industrial research involves the use of advanced scientific methods and calls for the highest degree of scientific attainment. The confusion is worse because the same scientific principles and methods of investigation are frequently employed in each case and even the subject-matter under investigation may sometimes be identical.

The misunderstanding arises from considering only the subject-matter of the two classes of research. The distinction is to be found not in the subject-matter of the research, but in the motive.

The electrical engineer, let us say, finding a new and unexplained difficulty in the working of electric lamps, subjects the phe-

nomenon observed to a process of inquiry employing scientific methods, with a view to removing from the lamps an objectionable characteristic. The pure scientist at the same time investigates in precisely the same manner the same phenomenon, but with the purpose of obtaining an explanation of a physical occurrence, the nature of which can not be explained by known facts. Although these two researches are conducted in exactly the same manner, the one nevertheless comes under the head of industrial research and the other belongs to the domain of pure science. In the last analysis the distinction between pure scientific research and industrial scientific research is one of motive. Industrial research is always conducted with the purpose of accomplishing some utilitarian end. Pure scientific research is conducted with a philosophic purpose, for the discovery of truth, and for the advancement of the boundaries of human knowledge.

The investigator in pure science may be likened to the explorer who discovers new continents or islands or hitherto unknown territory. He is continually seeking to extend the boundaries of knowledge.

The investigator in industrial research may be compared to the pioneers who survey the newly discovered territory in the endeavor to locate its mineral resources, determine the extent of its forests, and the location of its arable land, and who in other ways precede the settlers and prepare for their occupation of the new country.

The work of the pure scientists is conducted without any utilitarian motive, for, as Huxley says, "that which stirs their pulses is the love of knowledge and the joy of discovery of the causes of things sung by the old poet—the supreme delight of extending the realm of law and order ever farther towards the unattainable goals of the infinitely great and the infinitely small, between which our little race of life is run." While a single discovery in pure science when considered with reference to any particular branch of industry may not appear to be of appreciable benefit, yet when interpreted by the industrial scientist, with whom I class the engineer and the industrial chemist, and when adapted to practical uses by them, the contributions of pure science as a whole become of incalculable value to all the industries.

I do not say this because a new incentive is necessary for the pure scientist, for in him there must be some of the divine spark and for him there is no higher motive than the search for the truth itself. But surely this motive must be intensified by the knowledge that when the search is rewarded there is sure to be found, sooner or later, in the truth which has been discovered, the seeds of future great inventions which will increase the comfort and convenience and alleviate the sufferings of mankind.

By all who study the subject, it will be found that while the discoveries of the pure scientist are of the greatest importance to the higher interests of mankind, their practical benefits, though certain, are usually indirect, intangible or remote. Pure scientific research unlike industrial scientific research can not support itself by direct pecuniary returns from its discoveries.

The practical benefits which may be immediately and directly traced to industrial research, when it is properly conducted, are so great that when their importance is more generally recognized industrial research will not lack the most generous encouragement and support. Indeed, unless industrial research abundantly supports itself it will have failed of its purpose.

But who is to support the researches of the pure scientist, and who is to furnish him with encouragement and assistance to pur-

sue his self-sacrificing and arduous quest for that truth which is certain as time goes on to bring in its train so many blessings to mankind? Who is to furnish the laboratories, the funds for apparatus and for traveling and for foreign study?

Because of the extraordinary practical results which have been attained by scientifically trained men working in the industrial laboratories and because of the limited and narrow conditions under which many scientific investigators have sometimes been compelled to work in universities, it has been suggested that perhaps the theater of scientific research might be shifted from the university to the great industrial laboratories which have already grown up or to the even greater ones which the future is bound to bring forth. But we can dismiss this suggestion as being unworthy.

Organizations and institutions of many kinds are engaged in pure scientific research and they should receive every encouragement, but the natural home of pure science and of pure scientific research is to be found in the university, from which it can not pass. It is a high function of the universities to make advances in science, to test new scientific discoveries and to place their stamp of truth upon those which are found to be pure. In this way only can they determine what shall be taught as scientific truth to those who, relying upon their authority, come to them for knowledge and believe what they teach.

Instead of abdicating in their favor, may not our universities, stimulated by the wonderful achievements of these industrial laboratories, find a way to advance the conduct of their own pure scientific research, the grand responsibility for which rests upon them. This responsibility should now be felt more heavily than ever by our American universities, not only because the tragedy of the great war has caused the destruction of European institutions of learning, but because even a worse thing has happened. So great have been the fatalities of the war that the universities of the old world hardly dare to count their dead.

But what can the American universities do, for they, like the pure scientists, are not engaged in a lucrative occupation. Universities are not money-making institutions, and what can be done without money?

There is much that can be done without money. The most important and most fundamental factor in scientific research is the mind of a man suitably endowed by nature. Unless the scientific investigator has the proper genius for his work, no amount of financial assistance, no apparatus or laboratories, however complete, and no foreign travel and study, however extensive, will enable such a mind to discover new truths or to inspire others to do so. Judgment and appreciation and insight into character on the part of the responsible university authorities must be applied to the problem, so that when the man with the required mental attributes does appear he may be appreciated as early in his career as possible. This is a very difficult thing to do indeed. Any one can recognize such a man after his great achievements have become known to all the world, but I sometimes think that one who can select early a man who has within him the making of the scientific discoverer must have been himself fired with a little of the divine spark. Such surely was the case with Sir Humphry Davy, himself a great discoverer, who, realizing the fundamental importance of the man in scientific discovery, once said that Michael Faraday, whose genius he was prompt to recognize, constituted his greatest discovery.

I can furnish no formula for the identi-

fication of budding genius and I have no ready-made plan to lay before the universities for the advancement of pure scientific research. But as a representative of engineering and industrial research, having testified to the great value of pure scientific research, I venture to suggest that the university authorities themselves might well consider the immense debt which engineering and the industries and transportation and communications and commerce owe to pure science, and to express the hope that the importance of pure scientific research will be more fully appreciated both within the university and without, for then will come—and then only—that sympathetic appreciation and generous financial support so much needed for the advancement of pure scientific research in America.

While there are many things—and most important things—which the universities can do to aid pure science without the employment of large sums of money, there are nevertheless a great many things required in the conduct of pure scientific research which can be done only with the aid of money. The first of these I think is this:

When a master scientist does appear and has made himself known by his discoveries, then he should be provided with all of the resources and facilities and assistants that he can effectively employ, so that the range of his genius will in no way be restricted for the want of anything which money can provide.

Every reasonable and even generous provision should be made for all workers in pure science, even though their reputations have not yet become great by their discoveries, for it should be remembered that the road to great discoveries is long and discouraging and that for one great achievement in science we must expect numberless failures.

I would not restrict these workers in pure science to our great universities, for I believe that they should be located also at our technical schools, even at those with the most practical aims. In such schools the influence of a discoverer in science would serve as a balance to the practical curriculum and familiarize the student with the high ideals of the pure scientist and with his rigorous methods of investigation. Furthermore, the time has come when our technical schools must supply in largely increasing numbers men thoroughly grounded in the scientific method of investigation for the work of industrial research.

Even the engineering student, who has no thoughts of industrial research, will profit by his association with the work of the pure scientist, for if he expects ever to tread the higher walks of the engineering profession he must be qualified to investigate new problems in engineering and devise methods for their solution and for such work a knowledge of the logical processes of the pure scientist and his rigorous methods of analyzing and weighing evidence in his scrupulous search for the truth will be of the greatest value.

Furthermore, the engineering student should be taught to appreciate the ultimate great practical importance of the results of pure scientific investigation and to realize that pure science furnishes to engineering the raw material, so to speak, which he must work into useful forms. He should be taught that after graduation it will be most helpful to him and even necessary, if he is to be a leader, to watch with care the work of the pure scientist and to scrutinize the reports of new scientific discoveries to see what they may contain that can be applied to useful purposes and more particularly to problems of his own which require solution. There are many unsolved problems in applied science, to-day, which are insoluble in the present state of our knowl-

edge, but I am sure that in the future, as has so often happened in the past, these problems will find a ready solution in the light of pure scientific discoveries yet to be made. When thus regarded the work of the pure scientist should be followed with most intense interest by all of those engaged in the application of science to industrial purposes. Acquaintance, therefore with the pure scientist, with his methods and results, is of great importance to the student of applied science. I believe that there is need of a better understanding of the relations between the pure scientist and the applied scientist and that this understanding would be greatly helped by a closer association between the pure scientist and the students in the technical schools.

While I have drawn a valid distinction between the work of the two, they nevertheless have much in common. Both are concerned with the truth of things, one to discover new truths and the other to apply these truths to the uses of man. While the object of the engineer is to produce from scientific discoveries useful results, these results are for the benefit of others. They are dedicated to the use of mankind and, as is the case with the pure scientist, they should not be confused with the pecuniary compensation which the engineer himself may receive for his work for this compensation is slight, often infinitesimally so, compared with the great benefits received by others. Like the worker in pure science, the engineer finds inspiration in the desire for achievement and his real reward is found in the knowledge of the benefits which others receive from his work.

There are many other things which might be discussed concerning the conduct of pure scientific research in our universities and technical schools, but enough has been said to make it plain that I believe such work should be greatly extended in all of our American universities and technical institutions. But where are the universities to obtain the money necessary for the carrying out of a grand scheme of scientific research? It should come from those generous and public-spirited men and women who desire to dispose of their wealth in a manner well calculated to advance the welfare of mankind, and it should come from the industries themselves, which owe such a heavy debt to science. While it can not be shown that the contribution of any one manufacturer or corporation to a particular purely scientific research will bring any return to the contributor or to others, it is certain that contributions by the manufacturers in general and by the industrial corporations to pure scientific research, as a whole, will in the long run bring manifold returns through the medium of industrial research conducted in the rich and virgin territory discovered by the scientific explorer.

It was Michael Faraday, one of the greatest of the workers in pure science, who in the last century discovered the principle of the dynamo electric machine. Without a knowledge of this principle discovered by Faraday the whole art of electrical engineering as we know it to-day could not exist and civilization would have been deprived of those inestimable benefits which have resulted from the work of the members of this institute.

Not only Faraday in England, but Joseph Henry in our own country and scores of other workers in pure science have laid the foundations upon which the electrical engineer has reared such a magnificent structure.

What is true of the electrical art is also true of all the other arts and applied sciences. They are all based upon fundamental discoveries made by workers in pure science, who were seeking only to discover

the laws of nature and extend the realm of human knowledge.

By every means in our power, therefore, let us show our appreciation of pure science and let us forward the work of the pure scientists, for they are the advance guard of civilization. They point the way which we must follow. Let us arouse the people of our country to the wonderful possibilities of scientific discovery and to the responsibility to support it which rests upon them and I am sure that they will respond generously and effectively. Then I am confident that in the future the members of this institute, together with their colleagues in all of the other branches of engineering and applied science, as well as the physician and surgeon, by utilizing the discoveries of pure science yet to be made, will develop without marvelous new agencies for the comfort and convenience of man and for the alleviation of human suffering. These, gentlemen, are some of the considerations which have led me here in my presidential address to urge upon you the importance of a proper understanding of the relations between pure science and industrial research.

J. J. Carty

THE BOTANICAL FIELD EXCURSION IN COLLEGIATE WORK

The standard college course in general botany occupies a well-defined field, and is concerned with pedagogical problems quite distinct from those of the secondary school on the one hand, and of the university on the other. Many of the defects and shortcomings of collegiate botany as taught have been due to the fallacious idea that college botany is merely university botany pruned down to meet the supposititious mental ability of the college student. The ideas and technique of the university research laboratory have frequently been transplanted *en bloc* into the college classroom, with resultant pedagogic malpractise and scientific inefficiency.

College and university men are coming to realize more and more clearly that the university research laboratory has its peculiar problems, for which work it should be diligently protected and fostered; and also that the American college as an institution has its distinctive field and problems, and that the two fields, overlapping here and there, are on the whole widely separated from one another.

One of the notable lines of weakness of the collegiate course in general botany that has come to the writer's attention, is the comparatively rare or infrequent use of the field excursion. The usual schedule, to be found in most American colleges, consists of one or two trips in the autumn, a long winter session restricted almost exclusively to laboratory exercises, and a few desultory spring trips to collect flowering plants.

There are a number of factors which have combined to bring about this state of affairs. Most botany teachers are primarily laboratory-trained men. Frequently they are not very well acquainted with the region in which they teach. In many instances their own university work in botany was confined largely to the cytological, histological or morphological aspects of the science; with little or no practical training in field work, either from the scientific or pedagogical viewpoint. In most regions a large portion of the academic year is winter time, with much inclement weather, and plant life at a standstill. Laboratory exercises can be planned with much greater certainty and precision than can field trips. The problems of transportation and discipline on the field trip, particularly if the class be large, are often difficult and annoying. It involves much planning and extra work to break up a large class into small sections for field work. Field trips are time consuming, and in many regions the places of greatest botanic interest lie at a considerable distance from the college buildings. There are a great number of excellent printed outlines covering all the standard laboratory exercises and experiments; these laboratory guides and manuals are ready-made for the teacher's use, while field trips require the laborious preparation of special outlines by the

individual teacher.[1] For all these reasons, and for others that might be enumerated, the average college teacher finds it much easier, and on the whole more satisfactory to plan laboratory exercises rather than field excursions.

The present paper is an earnest plea for a larger recognition of field work as an *integral part* of any course in general botany. The field work should not usurp the place of legitimate laboratory studies, but on the other hand it should not be regarded, as it is generally regarded to-day, as a mere accessory, desirable but inconvenient. Ganong's statement may be appropriately quoted here:

> Very important too, are field excursions, the opportunity for which varies greatly. Theoretically, it might seem better if most botanical study could be done out of doors, but practically the greater part of it demands tools and other facilities, including physical comfort, unobtainable away from a good laboratory. In the excursions the teacher will of course direct attention to the larger phenomena of adaptation, the topography or physiognomy of the vegetation, the plant associations, etc. This kind of study will become much easier and more profitable in the near future as the subject becomes more fully systematized, and good books on it become accessible. It is especially important not to allow too great a number of students to go together on these excursions, and in my own experience not over ten can be profitably taken at any one time. The collecting instinct, so invaluable to the naturalist, should at such times receive every possible encouragement.[2]

Botany exists first of all out-of-doors, and the college student should have thoroughgoing training in field work as well as in the laboratory, herbarium and library. The college student, interested primarily in the large, significant, dynamic aspects of the subject, rather than in technical minutiæ, should be deeply imbued with the idea that he is working with an *out-of-door* subject, and that a valuable and essential part of the course is his own training in actual observation of *live* plants.

A pedagogical mistake that characterizes much botanic field work is the failure to place sufficient emphasis upon the vital, ecologic aspects of the studies. As Trafton[3] states,

> The demand for the study of physiology and ecology are protests against the old methods of looking on plants as lifeless things to be analyzed, classified, and laid away like minerals. It is insisted that the student shall be taught to look on plants as possessing life just as truly as do animals, and as having life problems to solve.

All too easily may a trip become a mere dilettante wandering, a grubbing up of plants, a hasty confusion of botanic names, a rude packing of specimens for herbarium or laboratory purposes. The essence of field work is to observe the plant *in its environment*, and to reason scientifically from these observations. As Adams[4] succinctly remarks,

> To learn how to study in the field, and not simply to collect, is one of the most important habits which a field naturalist and the ecologist has to acquire. This is one which he must, to a large degree, master alone, without the ready access to assistance, as is usually the case in the laboratory study. It is also a subject about which it is difficult to give useful suggestions, other than those of the most general character.

The herbalistic or laboratory routine, no matter how scientific and thoroughgoing, can never be more than a weak and shadowy substitute for these fundamental studies of organism and environment. Botany is not primarily in a *room*, it is out-of-doors; the workroom with its equipment and library is an adjunct to nature, and *not* the reverse. How often one finds botany taught as though the field and woodlands were merely a sort of glorified greenhouse, from which a few "types" and "illustrative specimens" were to be culled. Some teachers unconsciously create the impression that the plant kingdom exists primarily for the

[1] As an example of a recent text that does give suggestions for field work, E. F. Andrews, "Practical Botany," American Book Co., 1911, may be cited. Each of the ten chapters concludes with an excellent concise and suggestive section on field studies.

[2] Ganong, W. F., "The Teaching Botanist," Macmillan, 1899, pp. 64–65.

[3] Trafton, G. H., "Comparison of Methods of Teaching Botany," *School Review*, Vol. 10, 1902 (Feb.), pp. 138–145.

[4] Adams, C. C., "Guide to the Study of Animal Ecology," Macmillan, 1913, p. 37, Chap. 3, deals with field study.

purpose of providing material for paraffin sections and balsam mounts. To give college students real knowledge of plant life one must use living plants, and not merely skeletons and sections, no matter how important the latter are in their way.

As a concrete illustration of a general course in college botany that is given in an environment unusually favorable for field work, the writer will refer to the College of Hawaii, Honolulu. This institution corresponds in general status and organization to the state universities upon the mainland. Honolulu enjoys remarkably equable weather throughout the year; there are no storms; no frost, snow, ice or hail; thunder and lightning are very rare. There is no marked dormant season, and very few deciduous plants. The forests are evergreen, and most of the seed-plants have prolonged flowering periods. The climatic conditions are practically ideal for field work. In the immediate vicinity of the college is a remarkable variety of ecologic zones and habitats, ranging from the abyssal ocean to mountain peaks of three thousand feet elevation.

The botany course referred to is a freshman subject. There are two afternoon periods—two and one half hours each—and one lecture period per week. Customarily one of the afternoon periods is used for field work, the other for laboratory work. There are thirty-six weeks in the college year. The total number of field trips made by the class as a whole is about thirty. Students are encouraged to do individual field work and collecting, either on assigned topics, or those of their own choosing. This encourages the botanically-inclined student to develop a taste for original observations, and often prepares the way for special studies of genuine scientific merit.

The trips usually occur on Monday afternoon, as the experience of several years has proved this time to be the most satisfactory in connection with other features of the week's schedule. This permits the keeping-over of material collected, for the laboratory period, and facilitates a close coordination between field and laboratory work. The official period is two and one half hours, but the distances covered by some of the trips necessitate a considerably longer time than this, and field periods of three or three and one half hours are not uncommon. Occasionally, for the purpose of visiting some distant region of special interest, a double period is arranged by mutual agreement, and the excursion will occupy a period of five or six hours. On these occasions each student brings a light lunch, which is eaten at some convenient time in the course of the trip.

There are several types of excursions, which may be classed as follows:

1. *Systematic Collecting.*—To study in the field and collect for laboratory examination the plants of a given group or region; *e. g.*, green algæ; lichens; lycopods; Leguminosæ; strand plants; stream plants; swamp plants It is almost needless to point out that a certain amount of systematic collecting naturally forms a part of any field trip, irrespective of other objects.

2. *Ecologic Studies.*—Field studies of well-defined ecologic factors and adaptations; habitats with strongly marked characteristics; studies of zonation, invasion, competition, succession, etc.; relations of plant organs to environmental factors.[5]

3. *Field Studies of Plant Members and Organs.*—Particularly those organs and structures that are not adapted to bringing into the laboratory, *e. g.*, plank-roots, buttress roots; trunk types; bamboo; lianas *in situ;* epiphytes *in situ;* palm inflorescences; and many flowers.

4. *Phytogeographic Studies.*—Floral zones and regions in relation to their physiographic background; distinctive plants of the coral reef, lagoon, littoral, lowlands, valleys, summit ridges, peaks, etc.

[5] "On ecology of the structures they—the students—can do little better than guess at uses; for removed from their native homes, the plants can give no idea of their habits. Here is where the outdoor study of native plants through field excursions is most valuable." Ganong, *loc. cit.*, p. 206.

"Early in field work one should learn that the collection of specimens is not the primary aim of excursions, that specimens are only *one* kind of facts." Adams, *loc. cit.*, p. 41.

5. *Representative Plants.*—The phyla; important orders, families and genera; typical economics and ornamentals.

In all of the trips the students are encouraged to note any plants that are unknown to them. These are identified and listed; the last pages of the field notebook are utilized for this reference list of common plants. By this method, in the course of the year, the students learn the names of practically all the common plants of the region. As Clute cogently states,

> . . . the identification of plants is the only phase of botany in which the general public is interested; it is frequently the only part of botany in which the pupil is interested; and it is certainly the only part of botany that he follows up after he has left school. Doubtless every teacher has remarked the surprise of pupils when they discover that botany is not chiefly concerned with the names of plants.
>
> In any study, however, we can not do much without knowing the names of the objects with which we deal. Possibly there would be a much larger percentage of the people permanently interested in botany if our school courses early took cognizance of the desire for the names of things.[6]

At the beginning of the trip each student is provided with a typewritten or mimeographed outline which contains the essential topics, questions and directions for the trip. The topics and questions are numbered consecutively on the sheets, throughout the year, and the student numbers the paragraphs of his record to correspond with those of the outline. Inasmuch as the essential purpose of the trip is to strongly emphasize *individual observations* and first-hand familiarity with field material, the topics and questions are specifically planned and phrased with this object in view.

It is the practise of the teacher to devote a period of ten or fifteen minutes, early in the course of the trip, to a detailed explanation of the outline, so that every student knows exactly the character of the observations and studies to be made. At this time any questions are answered, individual assignments made, and every effort made to have the plan for the day thoroughly understood. This is a matter of great importance, as much time can be wasted through students not knowing exactly what is expected of them.

At this point it may be stated that each field trip is definitely anticipated in the lecture and recitation work, and much of the material and observations resulting from the trip are immediately used in the succeeding periods. The field trip is an *integral* working part of the course, and not merely a pleasant adjunct.

Some teachers utilize a somewhat less formal type of trip,[7] but it has been the writer's experience that the scientific results of an excursion are invariably in direct proportion to the fullness and precision of the outline.

An essential part of the equipment of each student is the *field notebook*. This is a small book, 3½ by 5 inches, with durable board covers and ordinary record ruling. In this book all of the original field notes and records are made, usually in pencil, and following the outline supplied at the beginning of each trip. The student numbers the pages consecutively, and the records appear in chronological sequence. At the end of the course a simple index is prepared by the student, listing the trips by subjects and places, and referring to the numbered pages of the book. The index is written on the first few pages of the book, which are left vacant for that purpose.

Much attention is given to the field notes as the record of the student's individual observations. A concise, simple style is encouraged. Technical terms are used when necessary, in a normal way, with no effort either to evade or to exaggerate their importance. Simple outline sketches, sections, profiles, diagrams and maps are used wherever they have

[6] Clute, W. N., "Teaching the Names of Animals and Plants," *School Review*, Vol. 15, 1907 (June), pp. 463–66.

[7] Clute, W. N., "Making Botany Attractive," *School Review*, Vol. 17, 1909 (Feb.), pp. 97–98. "Field trips are frequent, even in cold weather. Some trips are simply in quest of material and are made without an outline. Pupils are required to collect their own material and to note its relation to its surroundings and habitat. The trips with outlines are for the study of some phase of botany that can not well be studied indoors."

a legitimate place; the field drawings are necessarily rough, and are used, never for their own sake, but to supplement and elucidate the written statement.

It has been the experience of the writer that the freshman college student has a very vague idea as to essentials and non-essentials in field work and field records, and must be given systematic training in this. The records for the first few trips are examined by the teacher with particular care, and fully criticized and corrected. This is usually sufficient to give the student an accurate idea of standard field records. Insistence is placed upon the principle that field work must be genuine *field* work, and a rigid *tabu* is placed upon the writing up of notes from memory days after the trip has occurred. Two excerpts from Adams's[8] lucid statement may be pertinently reproduced herewith:

> The processes of observation and field study and note-taking are so intimately related that taking notes becomes one of the essential parts of careful observation. This is also one of the most difficult habits to acquire. The beginner is inclined to write them up, especially field notes, in the evening after his return from the field. Such notes are generally brief, lack details, and are usually of little value.
>
> We sometimes hear that reflections upon the work should be reserved for the return to the laboratory or study. This advice seems to be based on the assumption that study in the field is not particularly stimulating and suggestive. On the other hand, deliberating interpretatively in the midst of the problems under consideration is one of the most favorable conditions possible for the improvement of the quality and quantity of one's work.

A number of articles of field equipment are habitually taken on the trip, and are listed herewith.[9] Not all of these are taken on every trip; the kit is modified from time to time to suit the particular needs of the day.

[8] Adams, C. C., *loc. cit.*, pp. 41–42.

[9] The little book "Botanizing," by W. W. Bailey, Preston and Rounds, Providence, 1899, contains much useful information concerning botanical field work; especially Chap. 2, on equipment, Chap. 3, on collecting, and Chap. 4, giving directions for particular families.

1. *Vascula*—a number of small ones, one to each student, or to every two or three students, depending upon the character of the collecting; frequently one or two large vascula, for woody specimens or other bulky material.
2. *Diggers or trowels*—one or more, depending upon nature of collecting; the entomological collecting-tool listed by Kny-Scheerer has proved particularly satisfactory. Narrow garden trowels are good.
3. *Pocket-knives*—several large, strong knives, with sharp blades. The writer has been surprised and amused many times by the pocket-knife equipment of the average college student; the girls have none, and those of the men are usually wholly unsuitable for botanical purposes. Students are encouraged to supply themselves with good substantial pocket-knives, for as every field botanist knows, a surprising amount of botanical dissecting and anatomical work can be done with an ordinary *sharp* knife and a Coddington lens.
4. *Coddington lens*—one inch, in folding metal case; one for each student.
5. *Maps*—of the region to be visited, the largest scale obtainable; giving topography, hydrography, etc.
6. *Magnetic compass*—for use in connection with map work.
7. *Compound microscope*—portable type; occasionally taken, to provide for the demonstration, in the field, of certain structures —*e. g.*, algæ, fungi, sporangia, prothalli, elaters, pollen, protonema, etc.
8. *Dissecting kit*—in folding leather pocket-case, with scalpels, scissors, needles, etc., for field dissections.
9. *Field glasses*—prism binoculars; used on trips into the mountainous districts.
10. *Steel tape*—K. & E. 50 ft. Lilliput, very light and convenient; English and metric graduations; useful in many ways.

Miscellaneous vials, tin boxes, paper envelopes, twine, gummed labels, etc., as occasion requires.

For studies along the coral reefs and beaches waterboxes and collecting pails are taken.

Occasionally photographic equipment is taken, although this is made distinctly subsidiary to the other work of the trip.

A feature of the equipment that is by no means negligible is the item of clothing. Announcement of the trip is made a number of days, sometimes a full week, before the specified date, in order that all members of the class may have ample time to make any individual arrangements necessary. A statement is also made as to the general itinerary, the character of the country to be traversed, and the general nature of the garb most suitable for the trip.

Nothing is more disastrous to the pedagogical success of a trip than to have students appear in ill-adapted or wholly unsuitable clothing. One simply *can not* botanize in "good" clothes. Khaki trousers or skirts; headgear not susceptible to injury by the weather; leggins or puttees for protection against the numerous thorny and spiny plants of our lowlands; and, most important of all, comfortable, thick-soled, wide-heeled shoes—these are some of the features that make for successful field work. French heels, umbrellas and "wraps" are *tabu*, but the students are encouraged to bring field glasses, kodaks, or other equipment in addition to the botanical equipment, that will add to the interest of the trip.

In the first year course in general botany given at the College of Hawaii the following representative ecologic districts are visited:

1. *The Coral Reefs.*—This includes not only a survey of the plant life of the reef, but also a general study of reef formation; the reef as a habitat for plants and animals; the interrelations of marine organisms; the zonation of the reef and its waters; the rôle of plants as reef builders.

2. *The Beach.*—This includes the plant life of coral, tufa and lava beaches; the relation of plants to wave action; beach zonation; drift material; dissemination of plants by ocean currents; effects upon plant life of elevation and subsidence of beach levels; beach halophytism and xerophytism.

3. *The Lowlands.*—Comprising a variety of habitats—grassy plains; arid and semi-arid wastelands; salt-, brackish- and fresh-water swamps; streams and wet-lands; elevated limestone platforms; lava flows in various stages of disintegration; tufa cones and deposits; plant formations on volcanic ash and scoria.

Particular attention is given to the lowland flora, for although it is composed chiefly of introduced plants, it is the region in which the human population exists, and is therefore of chief interest. Problems of invasion, competition, adaptation, succession; dissemination; interrelations of insects and fungi to common lowland plants; crops, fruits, ornamentals and other economics; studies in xerophytism, mesophytism, etc.

4. *The Forest Zone.*—There are three divisions of the forest zone, lower, middle and upper; each of these has distinct humid and arid sections, with intergrading districts. In the vicinity of Honolulu only the lower and middle zones exist; the upper zone is confined to the lofty mountains of Maui and Hawaii. The forests within reach of Honolulu are chiefly humid or "rain" forests, although there are some xerophytic species. Topics: The conspicuous trees, shrubs and herbaceous plants of the forest; the forest as a watershed; the forest floor; animal life of the forest;[10] lianas and other specialized stem forms; precinctive species and varieties; landslides and other destructive agencies; relation of forest to precipitation, wind, elevation, etc.; conspicuous forest flowers and fruits; changes in the native forest within historic times; planted forests; forest conservation.

5. *Valleys.*—The Oahu Mountains are deeply dissected by steep-walled valleys, ravines and gorges. Many of these valleys are great amphitheaters of erosion. The humidity increases

[10] "Let no one worry if zoology and physical geography creep in hodge-podge with botany. They are apt to do that out of doors. Flowers do not object to the birds singing above them; I think an old tree likes to harbor a squirrel; and as for the boy who can gather spirogyra and not see a peculiar stone close by, he will never make a great naturalist."—Stuart, M. H., 1908, "The Botany Notebook, What it Should Contain and How it Should Be Made," *N. E. A. Proc.*, 1908, pp. 665–67.

progressively and conspicuously from mouth to head. Topics: plant zonation of the valley floor and walls; plant life of the stream and its borders; plants of precipices, spurs, hanging valleys and summit ridges.

The first trips of the course are short—across the college farm, and in the immediate vicinity—to familiarize the students with the general plans and methods of field work. The longest trips come late in the school year, after the class is thoroughly accustomed to field collecting and the ecologic point of view.

TYPICAL FIELD RECORD OUTLINE FOR THE STUDY OF A SEED-PLANT

1. *Name of plant*—Scientific; English; Hawaiian.
2. *Family.*
3. *Location*—as specific as feasible. (Students need training in accurate designation of localities.)
4. *Habitat*—distinctive features; soil; moisture; exposure; elevation; shade; plant associates; etc.
5. *The stand*—solitary; clumps; extensive pure stands; colonial; etc.
6. *Growth-form and duration*—herb; vine; shrub; tree; rosette; prostrate, etc.; outline sketch of profile, drawn to scale.
7. *Stem*—dimensions; characteristics of bark; mode of branching; cross-section of stem; mode of growth; special features and adaptations of stem, water-storage, etc.
8. *Foliage*—phyllotaxy; light relation. Description of leaf: blade—shape, size, color, texture, venation, apex, base, margin, other features; petiole—length, cross-section, etc. Collect six typical leaves for laboratory work. Variation; polymorphism; accessory structures. Leaf fall; leaf scars.
9. *Inflorescence*—abundance; location; kind; season.
10. *The flower*—color; odor; shape; size; flower buds; special features, nectaries, etc. Collect six flowers, in various stages of development, for laboratory work. Pack carefully to avoid crushing. Pollination—method and agents; desirable and undesirable insect visitors; protection of pollen from rain, etc., close-pollination.
11. *Fruit*—abundance; kind; size; shape; color; texture; dissemination. Collect six fruits in various stages of growth, for anatomical studies of fruits and seeds in laboratory.
12. *Seeds*—abundance; size; shape; color; dissemination.
13. Examine the various parts and organs of the plant for fungous diseases and insect pests, malformations, etc. Collect plenty of material for laboratory work.
14. *Root system*—if practicable, dig up several plants and determine character of roots, and area occupied by them. (Studies of roots in the field are very important, and constitute a much-neglected phase of botanical teaching. The writer strongly believes that at some point in the course the student should himself dig up and carefully examine the root systems of several representative plants.)
15. *Relations* of the individual plant to its associates—competition; commensalism; stratification; succession; etc.; visible evidence of adaptation.

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"EXPEDITE THE MAP"

A committee to "Expedite the Completion of the Topographic Map of the United States" has been formed on the invitation of the undersigned, and its circulars have lately been sent out to engineers and others in all parts of the country, asking their support of the movement. Although appropriations made by congress have been liberal, although a number of states have cooperated generously, and although topographic mapping has been industriously prosecuted by the U. S. Geological Survey for the last thirty-five years, only about 40 per cent. of our national domain is at present represented on standard topographic maps. The area annually covered was greater at first, when the work was less accurate, than now, since the demand for better maps has arisen: at the present rate, about a century will be required to complete the maps, and long before that time elapses the demand for maps of larger scale and still greater accuracy will retard the rate of progress, unless large funds are forthcoming. For ten years past, something over half a million dollars has been spent annually on field work alone. This large sum should be steadily increased until it is at least doubled, in order that too great a delay before maps of the whole country are available shall be avoided. A rapid increase in appropriations is not desirable, because only a relatively small number of trained topographers are available for the work; but the increase should be continued annually for some ten or fifteen years to come.

Every industry, art and science which demands a knowledge of the lay of the land is benefited by good maps of the area in which it is carried on. The general location of railways and highways, the planning of water-supply, irrigation and drainage projects, the prosecution of geological, soil and forest surveys, the development of water powers and the installation of electric transmission lines, the promotion of large-scale realty transactions such as are common in the less settled parts of the country, are all aided immensely if good topographic maps of their areas are available, and are correspondingly embarrassed if such maps are wanting. Practical men, who have had experience in mapped and in unmapped areas, can testify to the ease and the difficulty of work in the two cases.

It is the wish of the committee to secure letters from such men in all parts of the country as to the value of the maps in the surveyed areas and as to the need of maps in the unsurveyed areas. The testimony thus gathered will be submitted to the director of the U. S. Geological Survey, as the basis of an urgent request that he should ask for larger appro-

priations for topographic work; and if he does so, the correspondents of the committee to "expedite the map" will be requested to appeal to their congressmen in support of the director's budget. Readers of SCIENCE who have experience regarding the value and the need of maps are urged to take part in this campaign by writing to the secretary of the committee, Professor A. E. Burton, Massachusetts Institute of Technology, Cambridge, Mass.

The other members of the committee are Robert Bacon, president, National Security League, New York; Arthur H. Blanchard, consulting engineer, National Highway Association, professor of highway engineering, Columbia University, New York; G. P. Coleman, state commissioner of highways, Richmond, Va.; G. E. Condra, president, National Conservation Congress, State University, Lincoln, Nebr.; W. L. Darling, chief engineer, Northern Pacific Railway Company, St. Paul, Minn.; R. E. Dodge, president, National Council Geography Teachers, Teachers College, New York; A. B. Fletcher, state highway engineer, Sacramento, Calif.; W. Cameron Forbes, of J. M. Forbes and Co., Boston, Mass.; John R. Freeman, consulting engineer, Providence, R. I.; W. O. Hotchkiss, state geologist, Madison, Wis.; F. H. Newell, professor of civil engineering, University of Illinois, Urbana, Ill.; Joseph H. Pratt, state geologist, Chapel Hill, N. C.; Wm. Barclay Parsons, consulting engineer, New York; Charles A. Stone, of Stone and Webster, Boston, president, International Corporation, New York; Frank M. Williams, state engineer, Albany, N. Y.

W. M. DAVIS

HARVARD UNIVERSITY,
CAMBRIDGE, MASS.

THE COMMITTEE ON POLICY OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

THE committee on policy met at the Hotel Belmont, New York City, on Saturday, September 30, 1916, at 1 P.M. There were present: Messrs. Nichols, Woodward, Paton, Humphreys, Cattell, Noyes, Fairchild, Pickering, MacDougal and Howard.

Mr. Paton read an informal report from the committee on delegates to the meetings. This was followed by a general discussion, after which it was moved and carried that in subsequent letters sent by this committee the authorities be asked especially to send men who will take an active part in the proceedings.

Mr. Pickering made a report for the committee on the Colburn Fund. After discussion, it was moved that the report be approved and recommended to the council for adoption.

After discussion, Mr. Noyes moved to recommend to the council the appointment of a committee of seven on grants for research which shall be authorized to apply the income of the research funds of the association and that such committee be appointed by the president with the advice of the committee on policy.

The treasurer reported for the committee on investments. It was moved and carried that this report be presented to the council with the recommendation that it be published.

The treasurer made a verbal report on certain features connected with the funds of the association and offered to keep in the safety vault of the Carnegie Institution the bonds and other financial papers of the association in charge of two trusted accountants whom, by way of partial compensation, he proposed personally to make life members of the association. This offer the committee accepted with thanks.

Mr. MacDougal reported verbally on the San Diego meeting of the Pacific Division and a long discussion on the welfare of the association ensued.

Mr. MacDougal moved the appointment of a subcommittee of three to consider the relation of the association to scientific organizations in general, to report to the committee on policy in December. Carried. The chairman appointed as this committee, Messrs. MacDougal, Paton and Fairchild.

Mr. Humphreys brought up the question of the publication by the association, or under its auspices, of a distinctly popular journal.

This was discussed at length by Mr. Noyes and certain other members.

Mr. Noyes moved the appointment of a subcommittee of three to report at an early date on this matter. The chairman appointed as this committee, Messrs. Humphreys, Hale and Stratton.

[At this time the committee adjourned for dinner and reconvened at 8 P.M.]

The permanent secretary read a letter from Mr. George E. Hale, chairman of the National Research Council of the National Academy of Sciences, inviting the association to appoint a committee of three to confer with the committee of three of the National Research Council to discuss measures by which the American Association for the Advancement of Science may cooperate in the research council's work.

On motion, it was moved that the president of the association appoint a committee of three, including himself, to act in this manner. On account of its urgency, it was considered desirable to take this action without awaiting the meeting of the council. Carried.

Mr. Noyes reported that the committee appointed from the National Research Council for this purpose consisted of Messrs. Welch, Conklin and Noyes.

Messrs. Charles Baskerville and N. L. Britton, of the local executive committee, appeared by invitation and Mr. Cattell made a statement of arrangements for the New York meeting.

On motion, the committee expressed its approval of scientific exhibits at the New York meeting.

On motion, it was recommended that a member of the local executive committee cooperate with the permanent secretary in preparing the Preliminary Announcement and in arranging the program.

On motion, the nomination of Dr. Henry M. Howe, as vice-president of Section D, in place of Dr. Elmer L. Corthell, deceased.

The matter of "members emeritus," discussed at some length at the Columbus meeting and referred to the committee on policy for recommendation, was brought up by the permanent secretary. It was moved and carried to report to the council that, in the opinion of the Committee on Policy, the Jane M. Smith Fund will care for the most deserving of the cases of the kind under consideration in the council discussion.

At 10 P.M., it was moved and carried to adjourn until Tuesday, December 26, immediately after the meeting of the Committee of One Hundred on Scientific Research at the Hotel Belmont.

L. O. HOWARD,
Secretary

SCIENTIFIC NOTES AND NEWS

ON nomination of the Sectional Committee of Section G (Botany) of the American Association for the Advancement of Science, Dr. C. Stuart Gager, director of the Brooklyn Botanic Garden, has been elected vice-president and chairman of Section G for the coming New York meeting in place of Dr. Thomas J. Burrill, deceased. On similar nomination by Section D (Engineering), Dr. Henry M. Howe, past-president of the American Institute of Mining Engineers, has been elected vice-president and chairman of Section D for the New York meeting, in place of Dr. Elmer L. Corthell, deceased.

BY vote of the board of trustees a bronze bust of Professor Thomas Chrowder Chamberlin will be placed immediately in Rosenwald Hall, University of Chicago, thus recognizing his long service to the university. Dr. Chamberlin has been professor and head of the department of geology since resigning the presidency of Wisconsin University in 1892.

DR. HERMANN VON IHERING has resigned the directorship of the Museu Paulista, São Paulo, Brazil. His present address is Joinville-Hansa, Estado de St. Catharina, Brazil.

THE health of Professor James H. Kemp, head of the department of geology of Columbia University, has much improved. The trustees of the university have, however, granted him a further leave of absence for one year.

DR. ROBERT W. LOVETT, professor of orthopedic surgery at the Harvard Medical School,

has been appointed by the New York State Health Department to inaugurate a state-wide plan in cooperation with local authorities for the after care of patients who have suffered from infantile paralysis.

DR. R. K. NABOURS, professor of zoology in the Kansas State Agricultural College, has recently returned from a trip around the world. Some time was given to further study of the Karakule sheep situation in Russia and Turkestan. He reports it unlikely that any live stock can be transported from these countries for scientific or other purposes during the war.

DR. R. TAIT MCKENZIE, head of the department of physical education at the University of Pennsylvania, has returned after a year's leave of absence at Aldershot Military Camp and Hospital, of England, where he had charge of training convalescents. He was commissioned major in the regular army of the British Empire.

DR. R. W. SHUFELDT, of Washington, D. C., has been selected to take charge of the department of wild flowers in *The American Forestry Magazine,* beginning with. the November number.

DR. S. W. WILLISTON, professor of paleontology in the University of Chicago, lectured before the Science Club at the Kansas State Agricultural College, on September 23, on "Some Principles of Evolution." He also addressed the student assembly on certain aspects of progress in education.

DR. ALBERT JOHN COOK, D.Sc., formerly professor of entomology in the Michigan Agricultural College, for eighteen years professor of biology in Pomona College and more recently for five years state commissioner of horticulture in California, died on September 29, at the age of seventy-four years.

PROFESSOR FOSTER E. L. BEAL, a well-known economic ornithologist connected with the Biological Survey in Washington, D. C., and a civil war veteran, died at his home in Branchville, Md., on October 1, in his seventy-seventh year.

THE death is announced of Pierre Duhem, professor of theoretical physics in the University of Bordeaux.

THE death in Berlin is announced of Dr. Emil Deckert, professor of geography in the new University of Frankfort. Professor Deckert spent many years traveling in and studying the United States. His book, "Nord Amerika," gives the most complete description of the United States in the German language.

THE New England Intercollegiate Excursion has been postponed to October 28. The excursion is to the Blue Hills region of eastern Massachusetts and will be conducted by Professors W. O. Crosby and C. H. Warren of the Massachusetts Institute of Technology.

A STEP looking to a thorough sanitary supervision of the students of Yale University has been taken in the establishment of the university board of health. Student working and living conditions are to be studied and improved, and all students participating in athletics are to be carefully examined. Dr. James C. Greenway, '00, formerly on the medical attending staffs of the New York Hospital and of the Seton Hospital for Tuberculosis of New York, has been appointed university health officer. The board of health includes Dean George Blumer, of the medical school; Professor C.-E. A. Winslow, Dr. W. G. Anderson, of the gymnasium, and the deans of the undergraduate schools.

THE Municipal Reference Library of New York City has completed plans for establishing a public health division on the fifth floor of the Health Department building at 139 Center Street. It will specialize on child hygiene, drugs, food analysis, food inspection, food regulations, food supply, hospitals, health insurance, milk supply, occupational hygiene, school inspection, contagious diseases and vital statistics.

THE American Public Health Association will meet in Cincinnati, October 24 to 27. Its membership includes approximately 2,500 health officers of the leading cities in the United States and Canada; the executive officers of most of the state and provincial

health departments; officials of the United States and Canadian government health services; and in addition to these, many bacteriologists, chemists, sanitary engineers, sociologists and laymen interested in public health work. Within the association are six sections, composed of the members who are peculiarly interested in the special phases of public health work. The various interests thus represented are indicated by the titles of sections: Public Health Administration, Laboratory, Sanitary Engineering, Vital Statistics, Sociology and Industrial Hygiene. At the annual meeting there will be a program of meetings for the general association, and in addition, the several sections meet for the presentation of papers and discussions on topics relating to their several fields of work. The Cincinnati executive committee, consisting of Drs. E. O. Smith, J. H. Landis and W. H. Peters, are making arrangements to house and entertain 1,000 delegates to the annual meeting, and 150 delegates to the Municipal Health Officers' Conference of Ohio, which meets at the same time.

The surgeon general of the army announces that preliminary examination for appointment of first lieutenants in the Army Medical Corps will be held early in January, 1917, at points to be hereafter designated. Full information concerning this examination can be procured upon application to the "Surgeon General, U. S. Army, Washington, D. C." The essential requirements to secure an invitation are that the applicant shall be a citizen of the United States, between 22 and 32 years of age at time of receiving commission in the Medical Corps, a graduate of a medical school legally authorized to confer the degree of doctor of medicine, of good moral character and habits, and shall have had at least one year's hospital training as an interne, after graduation. Applicants who are serving this postgraduate interneship and can complete same before October 1, 1917, can take the January examination. The examination will be held simultaneously throughout the country at points where boards can be convened. Due consideration will be given to localities from which applications are received, in order to lessen the traveling expenses of applicants as much as possible. In order to perfect all necessary arrangements for the examination, applications should be forwarded without delay to the surgeon general of the army. There are at present two hundred and twenty-eight vacancies in the medical corps of the army.

The private collection of birds, birds' eggs and mammals made by Mr. George B. Sudworth, dendrologist of the U. S. Forest Service at Washington, has just been acquired by the New York State College of Forestry at Syracuse, as a part of the equipment for teaching and investigation in forest zoology. The collection was made largely in Michigan. It is for the most part composed of bird skins which number over 600 specimens and represent nearly 200 species. In addition there are 84 mounted birds. The collection of eggs includes 75 species, belonging to 226 clutches and making a total of 865 specimens. There is one egg of the passenger pigeon and there are two skins of this extinct species. There are 67 mammals. The total number of specimens amounts to more than 1,600. Such collections are now becoming rare, as most of them have been acquired by the large museums.

The report for the year 1914–15 of the Board of Scientific Advice for India consists, according to *Nature*, almost entirely of isolated summaries of the work done during the year by the several scientific departments and scientific institutions of the Indian government. As most, if not all, of these departments and institutions issue independent annual reports of their own, it is, to say the least, disappointing to find these technical summaries filling the report of a scientific body styled advisory; unless, indeed, the term "advice" be understood in the commercial or notificatory sense as merely indicating the existence in working order of these various departmental instruments of research. The advisory proceedings of the board occupy only thirty-seven lines of the 180 pages of the report, and all the information they afford is that the board accepted the programs of the several scientific departments, but would rather not have them

in so much detail in future; and that it recommends (*a*) that officers attending the next Indian Science Congress should be regarded as on duty, (*b*) that a catalogue of scientific serials prepared by the Asiatic Society of Bengal should be published at the expense of government, and (*c*) that experiments should be undertaken, as requested by the Punjab Veterinary Department, to determine the vitality of rinderpest virus under Indian conditions. *Nature* remarks: "Of any far-reaching advisory purpose, of any great original directive enterprise, of anything in the nature of spontaneous movement, this report shows no record; one looks in vain for any reference to scientific education, or even for a connected account—as contrasted with bald, disjointed departmental summaries—of the general progress of science in India, vital affairs in which a board of scientific advice might be expected to exercise a missionary influence, if not to take a commanding lead. The simple fact is that, so far as the advisory business goes, this Report of the Board of Scientific Advice for India is a document of the *ex-officio* genus; and it can scarcely be otherwise when the president of the board is merely an *ex-officio* hierarch of the Indian Secretariat, instead of being a man of science specially selected for his critical knowledge of scientific affairs."

We learn from the *Journal* of the American Medical Association that as a result of the report on the inexactitude of clinical thermometers, read by Mr. Woog at a recent meeting, the Paris Academy of Sciences appointed a commission to study the question. Mr. Grimbert, the reporter of this commission, believes that it is necessary to prohibit the sale of all thermometers the precision of which is not guaranteed by official control. The war having suppressed the importation from Germany, France depends for her supply on Switzerland, England and the United States, and there has been a considerable rise of price without a corresponding guarantee of precision. According to Mr. Woog, the central pharmacy of the army has been obliged to refuse as much as 80 per cent. of the shipments offered. The French manufacturers have assured the commission that they will soon be in a position to supply clinical thermometers at the same price as those obtained from Germany before the war, and that they are prepared to submit to official control. Furthermore, the director of tests at the Conservatory of Arts believes that it is feasible to reduce considerably the fee paid for testing thermometers.

UNIVERSITY AND EDUCATIONAL NEWS

Under the will of Eckley Brinton Coxe, Jr., late president of the University of Pennsylvania Museum, the university was bequeathed the sum of $500,000 as an endowment fund for the maintenance of the museum, its publications and expeditions. He also bequeathed the sum of $100,000 to the university, the income of which is to be used towards increasing the salaries of professors.

Seth Low, president of Columbia University from 1890 to 1901, and trustee from 1881 to 1914, by his will, bequeathed $15,000 to a cousin and $12,000 to the daughter of his former nurse, half of these sums to go to Columbia University on their deaths. On the death of Mrs. Low several educational bequests became effective. Canton Christian College will receive about $70,000, the University of Virginia, Berea College and the Tuskegee Normal and Industrial Institute will each receive about $50,000. Mr. Low gave large gifts to Columbia University during his presidency, including the sum of $1,200,000 for the erection of the library building in memory of his father.

Beginning with this fall the course of instruction in veterinary medicine at the University of Pennsylvania has been placed upon the same basis as other departments of the university in regard to the length of course, four full years now being required for the professional degree.

At New York University Professor John Charles Hubbard succeeds Emeritus Professor Daniel W. Hering as professor of physics; and

Professor Willard D. Fisher has been appointed professor of economics and director of the graduate division of business administration.

DR. JOHN C. SHEDD, who for the past year has been dean of Olivet College and for seven years head of the physics department, has entered upon his work as head of the physics department of Occidental College, Los Angeles.

DR. M. C. TANQUARY, zoologist on the Crockerland Arctic Expedition, returned to this country early in the summer and has recently been appointed assistant professor of entomology in the Kansas State Agricultural College. Mr. A. H. Hersh, of Princeton University, has been appointed instructor in zoology to succeed Mr. Ray Allen, who has accepted a position in Cornell University.

THE following laboratory appointments have been made in the laboratories of the University and Bellevue Hospital Medical College: P. V. Prewitt, A.M. (Missouri), instructor in physiology; E. R. Hoskins, Ph.D. (Minnesota), instructor in anatomy, and J. L. Conel, Ph.D. (Illinois), instructor in anatomy.

DR. L. V. HEILBRUN has been appointed to an instructorship in microscopic anatomy in the college of medicine of the University of Illinois. Last year he was associate in zoology at the University of Chicago.

DR. HARLAN L. TRUMBULL, instructor in chemistry in the University of Washington, has been promoted to be assistant professor.

DR. FREDERIC A. BESLEY has been appointed professor of surgery in Northwestern University Medical School and a member of the attending surgical staff at Mercy Hospital.

C. F. BURGER has been appointed instructor in plant pathology in the graduate school of tropical agriculture of the University of California at Riverside, and Alfred Free Swain, formerly of Montana State College and of Stanford University, assistant in entomology there. Ralph Patterson Royce, formerly livestock editor of the *Missouri Farmer*, has been appointed instructor in animal husbandry at the University of California Farm.

DR. JAMES E. BELL, instructor in chemistry in the University of Washington, has been called as associate professor to Throop Institute of Technology, Pasadena, Calif., where he will have charge of the work in inorganic chemistry.

DISCUSSION AND CORRESPONDENCE

DIFFUSION VS. INDEPENDENT ORIGIN: A REJOINDER TO PROFESSOR G. ELLIOT SMITH

IN the "crude sketch of views" published in SCIENCE for August 11, 1916, Professor Elliot Smith attempts to discredit a method in ethnology which he regards as dogmatic and to substitute for it another which he apparently regards as critical. The issue is the time-honored one of diffusion *vs.* independent development in culture.

It seems to the writer that the picture of the *modus operandi* of "most modern ethnologists" drawn in the initial paragraphs of Professor Smith's sketch is an altogether erroneous one. Without doubt the writers of the classical period of English anthropology often abused the concepts of "independent origin" and "psychic unity of mankind." Of them may be mentioned Spencer, Tylor, Lubbock, Frazer, Lang. The concept of the diffusion of culture through historic contact was, however, by no means foreign even to these thinkers, although they may have neglected to make sufficient use of it in their theoretical constructions. Tylor, in particular, was thoroughly conversant with the problems and manifold difficulties involved in the phenomena of cultural diffusion. As to the modern ethnologists, it would be hard indeed to mention one who has not at some time of his career grappled with the problem of diffusion *vs.* independent development, in material culture, art, religion, social customs. Nor is there one who in his interpretative attempts would make use of the concepts of "psychic unity" and "independent origin" to the exclusion of those of "diffusion" and "historic contact."

On the other hand, a school of thinkers has arisen within relatively recent years, who, following in the lead of Ratzel, have, however,

gone much further, and try to elevate the concept of diffusion to a universal interpretative principle of cultural similarities. This school is usually associated with the name of Graebner, while among its other adherents, to a greater or less extent, may be mentioned Foy, Ankermann, Schmidt and, in the most recent period, Rivers. While there may be little in common between the work of these men and that of the classical English anthropologists there is, however, one significant similarity in the method pursued: both schools of thinkers seize upon one of the two possible modes of accounting for cultural similarities and proceed to ruthlessly apply it in all instances. In the one case as in the other, then, the method is dogmatic and uncritical.

Having apparently embraced the articles of the Graebnerian faith, Professor Smith sees nothing in the concepts of "independent development" and "psychic unity" but "childish subterfuges" and even "a fetish no less puerile and unsatisfying than that of an African negro." This curiously detached attitude the professor attempts to justify by appealing to the testimony of history and of psychology. "The teaching of history," he asserts, "is fatal to the idea of inventions being made independently. Originality is one of the rarest manifestations of human faculty." As to psychology, we read:

> Nor does it appear to have struck the orthodox ethnologist [here again some names would be most welcome] that his so-called "psychological" explanation and the meaningless phrase "similarity of the working of the human mind" run counter to all the teachings of modern psychology. For it is the outstanding feature of human instincts that they are extremely generalized and vaguely defined, and not of the precise highly specialized character which modern ethnological speculation attributes to them.

As against Professor Smith's interpretation of the historic record the writer ventures to submit that the testimony of history proves beyond the shadow of a doubt that independent inventions do occur as well as that originality, while rare in its most pronounced forms, is in a more general sense as fundamental a trait of the human mind as is that of the absorption and assimilation of ideas. What, if not originality, may we ask, the accumulation of the "happy thoughts" of individual minds, could account for the constant improvements in technique and the neat adjustment and cooperation of parts to which bear witness the manufactures of uncivilized man, his traps and snares, his tools, weapons, canoes, rafts, houses and knots? And what is true of material culture applies equally to the domain of ideas. Again, if the term invention is given a wide application—as in this instance it should—can there be any doubt whatsoever that numerous and independent inventions have occurred of spirits, taboos and other worlds, of modes of navigation, methods of hunting, fishing, warfare, the making of fire, punishments, ceremonies, myths, social customs, etc. Now, it is a matter of common knowledge that among the things, ideas, processes, thus brought into being, there occur numerous similarities, parallelisms—brief, perhaps, but unmistakable—convergences. When, in referring to these, the modern ethnologist speaks of "psychic unity," he is not therefore guilty of that naïve utilization of the concept of human instincts so confidently ascribed to him by Professor Smith. Again we must urge the professor to name *one* ethnologist who can be shown to have attributed similarities in cultures to the working of "highly-specialized" human instincts. The "psychic unity" is but a substratum, a universal common denominator, without which the similarities referred to above could, of course, not be expected to occur; but the "psychic unity" is manifested no less in the mechanisms of cultural diffusion than it is in those of independent developments. In neither case does "psychic unity" become an explanatory factor. If there is such a thing as explanation in history, then the complete reconstruction of the historic event is the explanation the ethnologist would demand, in the case of diffusion as well as in that of independent development.

The realization of the equal theoretical status of diffusion and independent development presently resolves itself into the percep-

tion of a difference. From the point of view of ethnological technique the two principles can not be treated in an identical way, for whereas diffusion can be demonstrated, independent development does not, in the nature of the case, permit of rigorous proof. The assertion of independent development always involves the negation of diffusion, a negation based on negative evidence, absence of proof of diffusion. Thus, it could always be claimed that at some time somehow diffusion has occurred. Such a claim would be unanswerable. At the same time it is obvious that the above constitutes a methodologically impossible procedure. A relatively small number of cultural similarities—speaking in particular of primitive cultures—can be referred to diffusion by internal evidence. Such is the case when the similarities brought into juxtaposition are so complex and minute that the probability of their independent recurrence approaches or equals zero. But let us repeat, the number of such instances is small, far smaller than generally alleged, far smaller than one might wish. Outside of these cases there lies the tremendous array of cultural similarities which may have arisen through diffusion or by independent development. In all such cases independent development must be assumed until diffusion is proved or, at least, made overwhelmingly probable.

We need not here enter into a discussion of the highly complicated technique demanded of such demonstrations. Professor Smith voices the conviction that the high pre-Columbian civilization in America "was derived from the late New Empire Egyptian civilization, modified by Ethiopian, Mediterranean, West Asiatic, Indian, Indonesian, East Asiatic and Polynesian influences." Professor Smith does not furnish the proof of his contention; it would therefore be premature to pass judgment upon it. But the author forestalls the character of his proof. We read:

> The proof of the reality of this great migration of culture is provided not merely by the identical geographical distribution of a very extensive series of curiously distinctive, and often utterly bizarre, customs and beliefs, the precise dates and circumstances of the origin of which are known in their parent countries; but the fact that these strange ingredients are compounded in a definite and highly complex manner to form an artificial cultural structure, which no theory of independent evolution can possibly explain, because chance played so large a part in building it up in its original home.

It seems from this highly significant and interesting passage that Professor Elliot Smith will base his proof largely on quantitative and qualitative evidence derived from the constitution of the cultural complex itself. The publication of Professor Smith's work, notice of which is given in a footnote, will be awaited with the greatest interest and impatience by his American colleagues; and if his proof withstands the test of their open-minded examination, the critical ethnologist will be the last one to want to lift a stone for the destruction of what would then constitute an invaluable addition to our knowledge of the ancient civilizations of the world.

A. A. Goldenweiser
Columbia University

SOME OBJECTIONS TO MR. ELLIOT SMITH'S THEORY

To the Editor of Science: In your issue for August 11, 1916, there appeared a very interesting theory as to the origins of the pre-Columbian American civilizations. It is the belief of the writer of that article, Mr. G. Elliot Smith, that the distinguishing characteristics of American cultures (such as pyramidal structures, the use of irrigation canals, the custom of mummifying the dead, etc.) are derived, by means of a "great cultural wave," from the ancient civilization of Egypt. The "cultural wave" is said to have passed from the valley of the Nile into Assyria, thence to India, Korea, Siberia, the Pacific islands and America. The wave is said to have started about B.C. 900.

This theory is important. But there are several serious objections to it:

1. If Mr. Elliot Smith is right in thinking that the American aborigines in Mexico, Peru, etc., used pyramidal structures, numer-

ous irrigation systems, and many customs closely resembling those of the ancient Egyptians because their culture was really an offshoot of the Egyptian culture, how can it be explained that in all pre-Columbian America there was no such thing as a wheeled vehicle? Chariots of various sorts were much used in ancient Egypt, as well as in the intervening areas, yet there is not a shred of evidence to prove that the Indians of America ever knew anything even remotely resembling them. Had the founders of American culture come from an area where wheeled vehicles were known, is it not inevitable that they would have made use of such vehicles during their long journey? Does it not seem that wheeled vehicles would be more useful to them than pyramids, and that therefore they would have been remembered first on the arrival of the wanderers in their new land? It is difficult to believe that the American aborigines were the cultural descendants of a wheel-using people, for wheels, being essentially useful, would inevitably have persisted as a feature of their material culture, had that been the case.

2. In a like manner, one is puzzled by a lack of any ships or vessels of advanced type among the American Indians. Even in Mexico, Yucatan and Peru, where civilization was, in other respects, of a well-advanced type, there were no really complicated vessels before the coming of the Spaniards. On the coast of Ecuador there was found the most elaborate type of boat known to the Indian race. It consisted of a raft of light wood with a flimsy platform on which stood a rude shelter. A simple sail, sometimes even two, was used. Large canoes with sails were also used in Yucatan. Not one of these, however, is worthy to be compared with even the earliest and simplest ships used in Egypt.[1] It is known, of course, that boat-building reached very early a high development in Babylonia, India and China, through all of which the "cultural wave" is said to have passed.

3. Finally, the date B.C. 900 is altogether too late for the beginning of the alleged migration of cultures. If this migration took place at all, it must have left Egypt much earlier than this, for we have the Tuxtla statuette (dated about B.C. 100) to prove that even before the commencement of our era the Maya calendar had already gone through its long preliminary stages and was already in existence in practically its final form. No doubt every one will admit that the period B.C. 900–100 is entirely too short for a "great cultural wave" to roll from Egypt to America in. The year B.C. 1500 is much more likely to be the date needed.

In conclusion, the present writer admits that, despite the three objections here noted (and several others), there is a large amount of seemingly corroborative evidence that tends to support the views of Mr. Elliot Smith. It will, however, be a long time before American anthropologists will be forced to accept these views as final, and many tests, based on physical anthropology, history, archeology, etc., will have to be successfully applied before the Egyptian source of American civilization is finally proved.

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Boston, Mass.

[1] *Cf.* Joyce, *S. Am. Arch.*, 1912, pp. 60, 125, and Plate XIII.; Joyce, "Mex. Arch.," 1914, pp. 203 and 300; Beuchat, 1912, p. 651; Pinkerton's "Voyages," 1808–14, Vol. XIV., pp. 407–409; Torr, "Ancient Ships," 1895, pp. 2, 4, 9, etc., and Plate I.; Mookerji, "Indian Shipping," 1912.

RESEARCH FUNDS FOR PHARMACY

To the Editor of Science: On page 230 of Science the appropriation of $5,000 made by the regents for specific research in engineering is mentioned as the only research appropriation at Wisconsin outside of the agricultural grants. For the sake of completeness you may care to know that several years ago the state legislature made an appropriation of $2,500 for a pharmaceutical experiment station, the first one, and, thus far, the only one of its kind in this country. This entire sum, though small as compared with the agricultural grants, is devoted to research. The department of pharmacy also enjoys the income of the Hollister Fellowship Fund of $5,000

for research work. This amounts annually to between $250 and $300. In addition to this the State Historical Society has a fund of $12,000 from Mr. and Mrs. Hollister for a pharmaceutical library. The income of this fund is not being used for the purchase of books, but for historical research in pharmacy and publication of the results. Temporary grants, such as the sum of $500 for a research fellowship by the Association of Flavoring Mfg. of the United States, I suppose fall outside the field covered by the report of the committee.

EDWARD KREMERS

QUOTATIONS

SCIENCE AND INDUSTRY

THE privy council report on scientific and industrial research, of which we publish a summary this morning, is a very able document. It reveals a firm and comprehensive grasp of the subject. To begin with, it gives an account of the existing institution for promoting industry by science. In the National Physical Laboratory, the Engineering Standards Committee, the Imperial Institute, the Imperial College of Science and Technology, the engineering schools of Cambridge and Oxford, the technological departments of the other universities and the larger technical colleges, we possessed before the war an apparatus which would excite the enthusiastic admiration of native critics if they came across it in some other country where the arts of advertisement are better understood and more efficiently practised. It is true that the apparatus was comparatively young, and the use made of it miserably inadequate to its potentialities and to the need; but that was due to a general failure to appreciate either. It is a mistake to infer that we possessed no means for developing industrial science because a poor use was made of them through conservatism, lack of insight, and the obsession of cheap imports deceptively labelled "free trade." The war has changed all that. It has made manifest the need of applying far more energetically the means we have and of supplementing them, as the present report points out. The outbreak of war found us unable to produce at home many essential materials and articles for carrying it on; and since then it has become clear that the future maintenance of our industries in peace demands a new attitude and new efforts in this field on the part of all concerned. This is the sufficient reason for undertaking the reorganization and development of industrial science now, while we are still at war.

The two main things required are financial support and the cooperation of manufacturers. Of the two the latter is, in our opinion, both the more important and the more difficult to secure. If it is effectively secured, the rest will follow; if it is not, nothing else will be of much use. Our manufacturers have not been wholly indifferent to science. The steel industry of Sheffield leads the world in the application of scientific metallurgy to commercial production. Nowhere do the laboratory and the workshop cooperate more closely or with better results. And in recent years other branches of industry have been making a gradual advance in the same direction. But the great bulk of our manufacturing interests have stood aloof and clung to the old. So have the labor interests, which are still more obstructive to change. The British workman's dislike of novelty and his power of resistance are an insufficiently recognized element in the British manufacturer's conservatism. It is obviously useless to spend money on discoveries and new processes if the attempt to apply them leads to strife. This prospect is enough to deter men who might otherwise be inclined to take up research and experiment in their works, and it must be taken into account. But it is not the chief cause of manufacturing inertia. Nor is the small size of many business concerns, to which the report refers. Small concerns can not undertake large, far-reaching researches of a fundamental order; but that is no reason for general indifference or hostility to research. They can carry on scientific work of a different kind with a direct practical bearing on their own business. Some do, but they are few. In Germany they are many. The notion that works there which

employ a large proportion of scientific experts are all on a gigantic scale is quite mistaken. Even those which are on a gigantic scale were small once; they have become large through applying science. Some small works in this country are highly scientific; some very large ones are exactly the opposite. The chief cause of manufacturing inertia is the mentality of British business men, which is essentially practical and distrustful of ideas. But the shock of war has undoubtedly disturbed them, and there is some prospect of a change. It is essential to success, as the committee admit. "We recognize that unless the generality of British firms can be induced to alter their present attitude we shall have failed profoundly in one of our appointed tasks." Research has hitherto offered no career for able and enterprising young men in this country. So they have not gone in for it, and when a manufacturer did want a man he had to go abroad for him. It was a vicious circle. But we believe that in the new prospect now opening up the committee are right in advocating the policy of increasing the supply of men. The demand will follow.—*London Times.*

SCIENTIFIC BOOKS

The Mechanism of Mendelian Heredity. By T. H. Morgan, A. H. Sturtevant, H. J. Muller and C. B. Bridges. Henry Holt and Company, New York. 1915.

Students of genetics some six years ago learned with lively interest that Professor Morgan had discovered in the fly *Drosophila ampelophila* an example of inheritance parallel to that seen in the well-known descent of color-blindness in man. Substituting red eye and white eye in the fly for normal color vision and color-blindness respectively in man the phenomena were exactly similar. Hitherto no such case in an animal available for experiment had been known. We were aware of several instances, notably that of the moth, *Abraxas grossulariata,* the pigmentation of the silky fowl, and certain others in poultry, canaries and pigeons, in which analogous descents had been traced; but in all these the parts played by the sexes were reversed. From this evidence indeed it had been proved that in the moth and the birds the unfertilized *eggs* are differentiated into two classes, those destined to become females and those destined to become males. Obviously enough it would be inferred from the descent of color-blindness that in man the *sperm* was similarly thus differentiated into two such classes, destined to form females and males respectively, a phenomenon which Wilson and others had cytologically demonstrated in various insects. At this point the matter rested.

With the discovery of the peculiarities of *Drosophila* genetic research has passed into a new phase. The animal breeds rapidly, going through many generations in a year. It is inexpensive to breed, and the families consist of numbers which, relatively to those attainable in most subjects, are enormous. Since it first attracted Professor Morgan's attention it has been found to produce a long and intricate series of factorial varieties, or "mutations" as the authors prefer to call them, differing in the color of eyes and body, the sizes and shapes of the wings, and other respects, the number of these differences being now computed at more than a hundred. Professor Morgan and a band of enthusiastic colleagues set themselves with the utmost zeal to analyze the inter-relations of this mass of factors. Half a million flies have been bred, with the result that the data respecting the genetics of *Drosophila* in quantity now surpass those obtained from any other animal or plant. The advances made are on any estimate many and of quite exceptional significance. That much is certain. If we go further, and accept the whole scheme of interpretation without reserve we are provided with a complete theory of heredity, so far as proximate phenomena are concerned.

We may perhaps best approach the subject by reference to a class of facts with which all investigators are now familiar. Of the factorial differences detected in *Drosophila,* many of the more important were soon shown to be sex-limited, as we used to call it, the "limitation" being to males, just as in color-

blindness and some other sex limited affections in man. From an analysis of the descents of these characters Morgan concludes that such limitation is in reality only a special case of that complete or partial association of factors in their parental combinations which was first recognized as coupling and repulsion. These phenomena may in fact be all one. They are examples of linkage between factors, the second factor involved in the case of sex-limitation being that for sex. The fundamental identity of these linkage-phenomena had naturally been suspected. Difficulty, however, lay in the peculiarity of sex-limitation, that in it the linkage has never been observed to be other than complete. The new theory, as will be seen, represents this distinction in a simple and readily conceivable way, so that we are at once attracted. It may be remarked that linkage is no mere incident of technical genetics. We can readily perceive that it must play a great part in the control of heredity. Close resemblances of offspring to parents and grandparents in features and other attributes are common even in families of mixed races like our own. Such resemblances must depend on the coexistence of multitudes of factors, and could scarcely ever be perceptible if the factors were really distributed at random among the germ-cells. The theory provides a mechanism by which their associations may be governed.

From the beginning it was tempting to interpret the processes witnessed in the maturation of the germ-cells as the visible means by which factors are segregated. Cytologists have shown that when the chromosomes are formed anew from the rested nucleus their number and on the whole their forms are constant for the species. They may thus be regarded as having a permanence or individuality. Further, they consist of pairs, one of each pair doubtless representing the material contributed by each parent, the two contributions having retained their identity through all the divisions and changes which have happened since the original fertilization.

If, therefore, the number of genetic factors were never greater than the gametic or haploid number of chromosomes, we should obviously conclude that each chromosome carried one factor, and the ordinary distribution of factors would be produced by a random allocation of one chromosome from each pair to the set comprised in each gamete. But we know that the number of genetic factors in various types of life greatly exceeds the gametic number of chromosomes and consequently this simple account was discarded as insufficient. At this point we meet the first of the far-reaching suggestions which Morgan offers, namely that all the factors are linked together in groups, and that the number of the independent groups is that of the haploid chromosomes. This number in *Drosophila* is four, and it is claimed that, on genetic analysis, the various factors of *Drosophila* can be proved to be so interrelated as to constitute four linked groups and no more. Before wholly accepting a proposition of such magnitude we naturally entertain a provisional reserve, but it may be at once admitted that all the evidence available is capable of this construction. Among the animals and plants already studied are many in which the factors, apparently subject to no linkage, in number far exceed that of the haploid chromosomes, but Morgan is able to reply with force that the possibility of linkage in these cases has not been exhaustively investigated. Tests of the heterozygotes by breeding with double recessives on a considerable scale provide the only really sufficient method of detecting linkages. Such work (especially in plants) is commonly very laborious and has rarely been carried out. Thus, though the presumption would *a priori* seem to be rather against the view that linkage will be found so abundantly operating even in the familiar examples, the speculation is quite legitimate. That it is extraordinarily promising as offering at least a chance of positive progress must be obvious to all.

But if the factors enter the offspring in linked groups—the chromosomes of each pair representing severally the parental combinations—the formation of new combinations inside any one group must mean that there has

been an interchange or "crossing-over" between the two homologous chromosomes. We know that such new combinations can be formed. Gametes bearing them are produced in all cases in which the coupling or the repulsion—to use the older terms—is not complete. To account for the crossing-over of factors from one chromosome to its mate Morgan appeals to certain phenomena of twisting and interlacing of chromosomes in synapsis, first made prominent by Janssens, who observed them in Amphibia. It is suggested that in the course of this process of twisting the chromosomes may anastomose and again break, exchanging parts of their substance. For those unversed in practical cytology it is not quite easy to judge how far this hypothesis is in accord with observed fact. That twisting takes place in many types, especially Amphibia, is clear; but neither the figures reproduced from Janssens nor the originals from which they are taken—still less the very fragmentary observations of both Stevens and Metz from *Drosophila*—provide more than a slender support for this most critical step in the argument. It is to be hoped that the authors will before long tell us exactly upon what evidence they are here relying.

The formation, then, inside a linked group, of factorial combinations other than those which entered from the parents, is ascribed to crossing-over from one chromosome to its fellow or mate. At an early stage in the work, the curious and very significant fact was observed that in the male no such crossing over took place in regard to the various factors which had been proved to be *sex-linked*. The cytological interpretation of this discovery was ready to hand. In many forms, especially insects, the sperms have been proved to be of two kinds, those possessing an X chromosome, destined to form females, and those without this chromosome, destined to form males. If therefore the X chromosome carries the sex-linked factors—a supposition inevitable inasmuch as these factors are all destined to go into the daughters—and if there is no real mate to the X chromosome, evidently there can be no interchange or crossing-over here. Therefore in the case of sex-limited characters linkage is complete.

On tracing the growth of the theory or group of theories which have been built up on the *Drosophila* evidence the consideration just propounded stands out as the original foundation-stone. It was so introduced in the chief inaugural paper of the series. This "sex chromosome in the male has no mate," Morgan tells us, and consequently no interchange with it takes place.[1]

On reference, however, to the work of Miss Stevens (1908) whose paper is given as authority for the mateless condition of the X chromosome in *Drosophila ampelophila,* we read that she found extreme difficulty in studying the cytology of this creature, but ultimately satisfied herself that there is an unequal pair. The more recent cytological work of Metz relates entirely to the female, but in a note on the male he remarks

> so far as my observations go, they indicate an unequal XY pair in the male, without any additional piece attached to either. Neither my observations nor those of Miss Stevens are conclusive, however, owing to the difficulty of observing the chromosomes in these stages. The question is important for the bearing it has upon the breeding experiments with this fly, and we are doubly unfortunate in being thus far unable to settle it.[2]

In 1913, Sturtevant in introducing the first formal development of the theory of linear arrangement, presently to be considered, repeats that there is no crossing over among the sex-linked group of factors in the male, "since the male has only one sex-chromosome."[3] When we come to the book of 1915 the same authors have an entirely different conception of the cytological phenomena. There are two sex chromosomes in the male, and though as a matter of convention, one of them is represented as different from the other in shape, the reader is very properly told that the distinction has not yet been observed.[4]

[1] *J. Exp. Zool.*, 1911, XI., p. 383.

[2] *J. Exp. Zool.*, 1914, XVII., p. 49, *note*.

[3] Sturtevant, *J. Exp. Zool.*, 1913, p. 44.

[4] In the recent paper of Bridges (*Genetics*, I., 1916) the distinction in shape is stated to be a reality.

Without insisting too much on the point, we can not avoid noticing that this complex web of theory is so exceedingly elastic as to be capable of being fitted to a framework of cytological fact, the converse of that for which it was designed. Still, as some animals are found to have no second heterochromosome the suggestion that such a body, when present, may be inoperative might be offered in extenuation.

Presently we meet, however, a fact which is much more difficult to harmonize with the theory, though constituting one of the most novel and remarkable of the discoveries made in the *Drosophila* work. Not only do the sex-linked factors show no crossing over in the male, but experimental breeding shows that in the male there is no crossing over even of the factors composing the other groups. *Crossing over, in fact, in Drosophila, turns out to be exclusively a phenomenon of the germ cells of females.* This is a genetic discovery of the first magnitude, whatever its ultimate significance, but the cytological interpretation of crossing over must now bear a very considerable strain: for, on the one hand, though the absence of crossing over in the sex-linked characters had fitted well with the belief that the sex-chromosome in the male was unpaired, this chromosome is now admitted to be paired; and on the other hand the characters ascribed to the chromosomes known to be paired turn out to be equally unable to cross over in the male. It is with some surprise that we find neither in the book nor in the material previously published any coherent discussion of the difficulties thus created. If further cytological work shows that the chromosomes of the female twist and anastomose, but that those of the male do not, the chromosomal theories of heredity will receive a very remarkable support. Meanwhile on this part of the subject there is little more to be said.

Recombination then within the limits of a linked group is regarded as a consequence of crossing over, or the interchange of parts between one chromosome and its mate or homologue. This conception, whether well- or ill-founded, has led on to a further and very remarkable speculation. If the factors are carried by the material of the chromosomes, what more likely than that they, or rather the particles severally bearing them, should be arranged in a row, like a string of beads, along the length of the chromosome? The proportion of cross-over gametes might thus give an indication of the actual relative positions of the factors along the chromosome. On this inspiration, the intertwining of two strings of beads providing always the mechanical analogy, the numbers in the experimental families have been carefully studied. The percentage of crossovers is taken to indicate the position of the factors. Where there is no linkage, this percentage is, of course, 50, all combinations occurring in equal numbers. But if two factors AB show 50 per cent. crossing over and both A and B can severally be proved to be coupled to a third factor C, then all three may in reality be members of one linked group, and the fact that in the case of one pair there is 50 per cent. of crossing over may be a consequence of the relative positions of these factors in a linear series. The amount of crossing over can thus be interpreted as an indication of the relative positions of each factor in such a series. Upon this follows the great thesis of the book: that this series is in fact a row of points along each of the four chromosomes, and that the redistributions or recombination of characters can be correctly represented by strings of beads which twist together in pairs, breaking and joining each other at nodes. Whether this conception is sound or not, we accept it as a gallant attempt to move on. No other of equal promise has been offered and we must observe its development with cordiality and respect.

Confronted with a theory of so much novelty and importance, the reader's first desire is to examine the details of the evidence from which it has been deduced. A serious charge lies against the book inasmuch as the material for such an examination is not contained in it. We are provided with a sketch—a vigorous and impressionist sketch—of the facts as the authors see them, but we want a much

nearer view. Pending this, judgment must be suspended. We are told that the breeding numbers prove the factors to be in four linked groups. We would like to take each one separately and follow the proof regarding its linkages. As yet there is no means of doing this. Of the evidence the book avowedly gives illustrative specimens merely, and even the long array of *Drosophila* papers leaves great gaps unfilled. Take the first or sex-linked series. The book tells us that more than 40 factors have been located in it and arranged in order. Respecting the great majority we have no details at all and as to most of the remainder very few. There are, however, six that we can examine in the light of the data summarized by Sturtevant in *Zeits. f. Vererbungsl.*, 1914, the last considerable body of evidence to hand.

The factors concerned, called Y, W, V, M, R, Br, are represented as arranged along the chromosome in such a way that two, Y and W, are at the zero end, two more, V and M, near together at 33.5 and 36.5, and the remaining two, R and Br, also near together at 53.3 and 57.7. The numbers indicate that the members of each set of two are closely linked, for with fair consistency the breeding ratios are those characteristic of close "coupling," namely, *n*AB: 1Ab: IaB: *n*ab, and of "repulsion" in the form IAB: *n*Ab: *n*aB: 1ab, the value of *n* being much greater than 1. The relations of Y and W to V and M are also of this kind, the coupling being of course less close. But taking Y with R, W with R, V with R, or M with R, we meet numbers of a very different order, and it is not clear by what system they have been interpreted. For instance, we find the following extraordinary series given,

for *Y* with *R*				
as *repulsion*	342	58	466	19
as *coupling*	235	50	194	56
for *W* with *R*				
as *repulsion*	567	143	697	91
as *coupling*	294	61	175	108
for *V* with *R*				
as *repulsion*	147	147	520	36
for *M* with *R*				
as *repulsion*	430	795	1,716	189
as *coupling*	4,189	93	850	1,033

The numbers in which the new combinations come are then added in each case and set out as percentages of the totals, these percentages being taken as indications of the linear distances between the loci in which the factors are presumed to be. To those accustomed to series of this class, these numbers are so aberrant as scarcely to suggest *prima facie* that they represent Mendelian series at all, and it seems at least improbable that they can be used to calculate percentages comparable with those obtained from the various comparatively normal series by which for instance Y and M, V and Bz,[5] Y and W, or W and M are interrelated. Throughout the experiments indications of differential viability recur, largely masking the true proportions of the classes, but as has been remarked by the authors in reference to certain special cases, the incidence of this differentiation is so irregular that allowance can not be made for it in any consistent fashion. Meanwhile the data look so intractable that a doubt has sometimes arisen whether the account here given may not be a consequence of some radical misunderstanding of the author's meaning.

One is tempted further to ask whether all parts of the several proofs are really independent of each other. In the present state of the evidence only the authors themselves can positively answer this question. They declare that all the factors are proved to be disposed in four separate systems of linkage, but the argument that they are thus arranged contemplates a very great variety of possibilities not obviously included in this scheme. For example, the fact that two pairs of gens or factors give 50 per cent. of cross-overs might in the authors' view be a consequence of the location of the two pairs in distinct chromosomes. It may equally be a consequence of the two being in the same chromosome but at the terminal and central positions respectively. It may also

[5] The numbers given for V and Br by Sturtevant are misprinted, 260 standing for 2,660. Thus emended they are fairly normal. The worst examples all involve *R*, and it might be suspected that this was a source of special difficulty, but analogous numerical abnormalities occur also in the "second chromosome" series, nor can any hypothesis of differential viability be readily applied to such figures as those quoted above.

be produced by double or triple crossing over, and in other ways also. Moreover, granting that the factors seem to be related to each other in four systems of linkages, it must next be proved that there is no linkage between members of distinct systems. The evidence of such independence is admittedly meager, and indeed as to the behavior of the factors comprised in the third system we have been told very little at all.

The machinery for dealing with unconformable cases is extraordinarily complete. Besides differential viability we hear of some twelve lethal factors by whose operation certain classes may be extinguished; changes in output with age; a special phenomenon spoken of as "interference" inside single chromosomes; some interaction between chromosomes; even of a factor modifying the normal amount of crossing over, and lastly of an altogether distinct kind of crossing over in the four-strand stage. Can the action of all these processes be severally traced? Can their consequences be distinguished from each other, and especially from those of multiple crossing over? There remain, of course, also the various slips to which all experimental work is liable, such as in this case errors from the overlapping of generations—several times alluded to as a real danger—and others similar which no doubt have been obviated more or less with the improvement in technique. Apart from obscurities of this more superficial kind, is it clear that the series of alternative hypotheses is capable of ultimate analysis? As has been already said, the authors may be able to make such an analysis, but they have not yet offered it to the reader in irrefragable form. Meanwhile the suspicion is unavoidable that, given a conviction that the factors *must* be arranged in rows along four chromosomes, the various interpretations provide rather a method, or perhaps we should say alternative methods, by which the facts can be reconciled with the hypothesis, than a proof that this hypothesis is correct.

Ever since the discovery of systems of linkage it has not been in dispute that several factors, perhaps all, are arranged in some ordinal system or systems. We are dealing with phenomena of *linkage*. The hypothesis of reduplication was offered as one way in which the processes could be logically represented, at least in plants. It is admittedly a very crude conjecture, but it has the merit of being noncommittal and applicable to units of various magnitudes. So much may be remarked in parenthesis; but the critical point now is whether in the various forms of life the number of independent factors, or systems of factors, is or is not greater than the haploid number of the chromosomes. The determination of this question all students of genetics will now await with keen interest.

In all the various parts of the subject explored, whether the main theory prove ultimately to be truth or fallacy, there can be no doubt as to the extraordinary value of the *Drosophila* work as a whole. Of the discovery that may perhaps come hereafter to be regarded as the most illuminating of all—the phenomenon of "non-disjunction"—we have still to speak. The exploration of this group of facts has been made by Bridges, who, since the brief note contained in the book, has published in *Genetics* a detailed account of his experiments. With this publication it must be admitted we are lifted on to something like solid ground. Hitherto amidst all that cytology has contributed, in one respect only has it been found possible to connect quite positively cytological appearances with somatic characters. That in certain forms of life sex is connected with the X chromosome is the one unambiguous fact.

To this Bridges now adds evidence of a new and very remarkable kind. In crosses between females with recessive eye color and normal "wild" males, the daughters normally resemble the father and the sons the mother. As exceptions, "matroklinous" daughters are produced, that is to say in this case with eyes of the recessive color. It was argued *a priori* that such a result might be reached if the *two* X chromosomes of the female were by some chance together passed into an ovum and that ovum were fertilized by a Y-bearing sperm. Such a zygote would be female by virtue of the

two X chromosomes. But for this it would have been male, for it is fertilized by the sperm normally destined to males. Since also all the dominant sex-linked factors possessed by normal males are borne by the sperm normally destined to daughters, the sperm that the exceptional daughter receives is recessive, and therefore these daughters are matroklinous. It follows as a corollary from this argument that fertilization might take place between ova bearing no X at all and a sperm bearing X, and it is said that such a class has been actually recognized as consisting of sterile males. Once the matroklinous daughter has appeared, by breeding from her, a complex variety of consequences may be expected, all deducible from the *a priori* analysis. In the breeding experiments, apart from certain numerical aberrations still unexplained, these have now all been realized experimentally.

Cytologically also the expected appearances have been found—in the sense that egg cells of the "exceptional" females have been seen to contain three instead of two of the chromosomes which the authors now agree are the heterochromosomes. Moreover, from an XXY female it should be possible to breed an XYY male and the two in combination may lead to forms with XXYY, and figures are given showing that these also have been produced and cytologically demonstrated. No one can doubt that this is a very fine achievement. Though still sceptical as to the adequacy of the theory of cross-overs and especially of the soundness of the arguments by which the factors are assigned to serial positions in the chromosomes, it is difficult to see how we can deny that the sex-linked characters have some very special relation to the sex-chromosomes.

In our present ignorance of the nature of life we cannot distinguish cause and effect in these phenomena and it is not possible to attach any satisfactory meaning to the expression that the sex-linked factors are "carried" by a chromosome, but if any one wishes to describe the association of the phenomena in that way there is nothing to forbid him. The properties of living things are in some way attached to a material basis, perhaps in some special degree to nuclear chromatin; and yet it is inconceivable that particles of chromatin or of any other substance, however complex, can possess those powers which must be assigned to our factors or gens. The supposition that particles of chromatin, indistinguishable from each other and indeed almost homogeneous under any known test, can by their material nature confer all the properties of life surpasses the range of even the most convinced materialism. Hence it may well be imagined that even if cytologists decide that in synapsis there is no anastomosis and no transference of material, the effective transference of the gens may occur. The transference may be one of "charges." Perhaps even we might profitably consider whether the chromosomes may not be thrown up, and the gens grouped along their lines by the interplay of the same forces.

Though as must frankly be admitted the *Drosophila* work is on the whole favorable, and in certain respects strongly favorable, to the view that all segregation is effected at the reduction division, it may be well to remind the workers in this field of the phenomena which are inconsistent with that conception. There are, of course, the old difficulties that if the chromosomes play this prerogative part we should expect some broad consistency between their differentiation and that of the forms of life, and we should not anticipate that they would be capable of great irregularities of number and behavior. But apart from these there remain the perfectly authenticated instances not merely of somatic differentiation in regard to Mendelian characters, but the whole range of bud-sports and chimæras of various kinds, and lastly the indubitable evidence that the male and female sides of the same plant may have distinct genetic properties. Such facts, to be sure, are no indication as to the powers of chromosomes, but they are a strong indication that the reduction process is not the only moment at which segregation may be effected. Presumably the advocates of chromosomal views would admit that these are exceptions, but still they are exceptions of a most significant kind. Conceivably we may

be led to the conclusion that there is some radical distinction between plants and animals in these respects.

Many matters of importance are treated in the book, especially the vexed question of the nature of "mutations," to which no justice can be done here. All that can be now attempted is an outline of the essential discoveries. To some it may seem that the disposition of this article is towards undue scepticism. To doubt the theory of cross-overs, for instance, at this date is almost in effect to "draw an indictment against a nation," which we know on high authority is an impossible task. Let it then be explicitly said that not even the most sceptical of readers can go through the *Drosophila* work unmoved by a sense of admiration for the zeal and penetration with which it has been conducted, and for the great extension of genetic knowledge to which it has led—greater far than has been made in any one line of work since Mendel's own experiments.

W. Bateson

PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES

The ninth number of Volume 2 of the *Proceedings of the National Academy of Sciences* contains the following articles:

The Mechanism of Diffusion of Electrolytes through Animal Membranes: Jacques Loeb, Rockefeller Institute for Medical Research, New York. For the diffusion of certain electrolytes through animal membranes there is required besides the osmotic pressure a second effect called the "salt effect" upon the membrane. This consists probably in an ionization of the protein molecules of the membrane.

The Rotation and Radial Velocity of the Spiral Nebula N.G.C. 4594: Francis G. Pease, Mount Wilson Observatory, Carnegie Institution of Washington. The radial velocity is + 1,180 km., in good agreement with the value found by Slipher. The linear velocity of rotation at a point 2 minutes of arc from the nucleus is over 330 km.

A Simple Method for Determining the Colors of the Stars: Frederick H. Seares, Mount Wilson Solar Observatory, Carnegie Institution of Washington. The method suggested consists in determining the ratio of exposure-times which is necessary to produce photographic and photovisual or more briefly, blue and yellow, images of the same size.

Studies of Magnitudes in Star Clusters, III. The Colors of the Brighter Stars in Four Globular Systems: Harlow Shapley, Mount Wilson Solar Observatory, Carnegie Institution of Washington. It is concluded that in all the clusters examined and probably in all globular clusters the volumes of the bright red stars are very great in comparison with the stars that are fainter and relatively blue.

The Effect of an Electric Field on the Lines of Lithium and Calcium: Janet T. Howell, Mount Wilson Solar Observatory, Carnegie Institution of Washington. Lithium and calcium were examined both for longitudinal and transverse effects.

A Proof of White's Porism: A. B. Coble.

A Contribution to the Petrography of the Philippine Islands: J. P. Iddings and E. W. Morley, Brinklow, Maryland and West Hartford, Conn. Six detailed analyses are given of rocks from Luzon, P. I.

Salt Antagonism in Gelatine: W. O. Fenn, Laboratory of Plant Physiology, Harvard University. The experiments on gelatine support the hypothesis that anions antagonize cations in their effects upon organisms. The hypothesis here developed resembles that of Clowes except that it requires that NaCl should antagonize any electrolyte which has either a strong anion or a strong cation. The point of maximum antagonism is an isoelectric point at which the amount of alcohol needed for precipitation is at a minimum, and the aggregation or amount of precipitation is at a maximum.

Similarity in the Behavior of Protoplasm and Gelatine: W. O. Fenn, Laboratory of Plant Physiology, Harvard University. A close analogy to Osterhout's experiments on the electrical resistance of *Laminaria* is found in gelatine (plus NaOH), if we assume that the effect of time in the *Laminaria* experi-

ments is to increase the concentrations of the salts in the cells of the tissue.

On Certain Asymptotic Expressions in the Theory of Linear Differential Equations: W. E. Milne, Department of Mathematics, Bowdoin College. Formulas more precise than those previously obtained by Birkhoff are given.

On Newton's Method of Approximation: Henry B. Fine, Department of Mathematics, Princeton University. A condition is given under which Newton's method of approximation for computing a real root of an equation, and the extension of this method used in computing a root of a system of equations, will with certainty lead to such a root or solution.

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SPECIAL ARTICLES

THE FUNCTION OF THE APYRENE SPERMATOZOA

SINCE the discovery of the dimorphism of spermatozoa in *Paludina* by von Siebold, 1836, numerous biologists have worked with this strange phenomenon without being able to find a conclusive explanation. On the one side investigators were found, like v. Brunn, who regarded the abnormal type of spermia as abortive elements without any function, whereas others, like Brock and Auerbach, thought it impossible that such typical elements could be produced regularly without being functional. It is well known how a new basis was given to these discussions, when Meves (1903)[1] worked out the details of the spermatogenesis of these two types of spermatozoa. He first proved that the atypical spermia in Prosobranchs contain only a small part of the chromatin of the cell and called them *oligopyrene* spermatozoa. He further discovered a similar dimorphism in some moths, but here the atypical spermia contain no chromatin at all, they are apyrene. Meves could get no evidence regarding the possible function of these elements, but he felt sure that they must have some function and pointed to the possibility of a fertilization by these elements, which would be interpreted as an "Entwicklungserregung." Since then much morphological work upon the structure and development of the atypical elements has been done, especially by Retzius, Kuschakewitsch, Reinke,[2] which, however, does not interest us here.

The interest in the possible function of these elements was awakened again, when the facts about the sex-chromosomes became known and their relation to the other kind of dimorphism of spermatozoa in insects and the mechanism of sex inheritance. The idea was promoted by R. Hertwig[3] that this dimorphism might also be connected with sex-determination and he tried to fit these possibilities into his general ideas of sex-determination, considering the possibility of fertilization by apyrene spermatozoa as a kind of male-producing parthenogenesis. These ideas were the starting point of some work which Popoff[4] did with *Paludina*. But he was unable to prove that the oligopyrene spermatozoa of that snail take any part in fertilization, although they are found in sufficient numbers in the oviduct. The only positive result was that in impregnated snails the oligopyrene spermia degenerate and die much earlier than the normal ones. Lamas,[5] who later studied the fertilization of *Murex*, was also unable to find any such spermatozoon inside the egg. On this point we have only a single positive observa-

[1] Meves, F., "Ueber oligopyrene und apyrene Spermien und ueber ihre Entstehung nach Beobachtungen an Paludina und Pygaera," *Arch. Mikr. Anat.*, 61, 1903. See there the quotations of the previous literature.

[2] Retzius, G., *Biol. Unters.*, N. F., Vol. 12, 13, 14, 1905–1909. Kuschakewitsch, S., "Studien über den Polymorphisms der männlichen Geschlechtselemente bei den Prosobranchia," *Arch. Zellforschg.*, 10, 1913 (complete literature). Reinke, E. E., "The Development of the Apyrene Spermatozoa of *Strombus tuberculatus*," Publ. 183, Carnegie Inst., Washington, 1914.

[3] Hertwig, R., "Ueber Correlation von Zell- und Kerngroesse, etc.," *Biol. Centrbl.*, 23, 1903.

[4] Popoff, M., "Eibildung bei Paludina vivipara, etc.," *Arch. mikr. Anat.*, 70, 1902.

[5] Lams, H., "Recherches concernant le dimorphisme des éléments sexuels chez le Murex," *Ann. Soc. Med. Gand.*, 89, 1910.

tion given by Kuschakewitsch.[6] He found in the eggs of a prosobranch, *Aporrhais*, twenty minutes after fertilization, an oligopyrene spermium besides a typical one. Even taking it for granted that this is not an accident of sectioning, the facts are not yet convincing. And Kuschakewitsch himself is indeed rather skeptical and does not want to draw far-reaching conclusions. It might be mentioned that we had formulated a hypothesis[7] of sex-determination on the basis of such a process which, however, we have since abandoned. The latest work on these questions, by Reinke (*l. c.*) finally reached one positive, but rather discouraging result. He finds in *Strombus* that the atypical spermatozoa never reach the receptaculum seminis but degenerate and are surrounded by a capsule. The simultaneous work of von Kemnitz[8] also failed to attain positive results, although the fact is of interest that the hermaphroditic prosobranch *Valvata* exhibits no dimorphism of spermatozoa.

As far as we know, only once has a real experiment been performed to test the function of the apyrene spermatozoa. R. Hertwig[9] started from the hypothesis that fertilization with apyrene spermia is comparable to the parthenogenesis and produces males. Therefore he crossed two species of moth, *Pygœra anachoreta* and *curtula,* which are known to produce apyrene spermia. If fertilization could occur by these latter sex-cells, the offspring, supposedly the males, ought to exhibit only maternal characters. The results were entirely negative, both sexes in F_1 being intermediate in regard to the characters of the parental species.

[6] Kuschakewitsch, S., "Zur Kenntnis der sogenannten wurmförmigen Spermien der Prosobranchier," *Anat. Anz.*, 37, 1910.

[7] Goldschmidt, R., "Kleine Beobachtungen und Ideen zur Zellenlehre," I., *Arch. Zellforschg.*, 1910.

[8] V. Kemnitz, G., "Beiträge zur Kenntnis des Spermatozoendimorphismus," *Arch. Zellf.*, 12, 1914.

[9] Hertwig, R., "Ueber den derzeitigen Stand des Sexualitaetsproblems, etc.," *Biol. Centrbl.*, 32, 1912.

We are now able to state a few experimental facts in regard to the apyrene spermia of moths which have been noticed in connection with some other work. The first question is are the apyrene spermia able to fertilize an ovum or to cause development? Some answer is given by the following facts. In my experiments on intersexuality in the gipsymoth an almost complete series of intersexual males was produced in 1915 showing every stage from a male to a female. Now up to a certain degree of intersexuality these individuals behave sexually like males and succeed in mating with the females. For many years we have known that such intersexual males of a low grade are completely fertile, and the eggs fertilized by them develop normally. It was of course of extreme importance for our work to breed offspring from the higher grades of intersexual males and they were therefore all mated, obviously to the limiting type, which was still male enough to perform the mating. All matings were certainly normal, as every female laid a normal egg sponge, which is only done after a successful mating. From the eggs fertilized by low-grade intersexual males the normal percentage of caterpillars hatched, as in previous years. But from egg batches, fertilized by somewhat higher intersexual males, only a few caterpillars hatched, the rest of the eggs being unfertilized. The numbers were for four cultures 3, 3, 2, 3 caterpillars, the egg batches containing between 100 and 300 eggs. Finally, in the egg batches laid after mating with the highest type of intersexual male, which was still able to mate, not a single egg developed. Now in studying the sex glands of these males we found that in low grade intersexuality they contained normal sperm bundles, but in the higher forms of intersexuality the entire gonad was filled with giant bundles of apyrene spermatozoa. The intermediate forms, which gave a few fertile eggs, were unfortunately not examined. We think it not unsafe to conclude from these facts that apyrene spermatozoa can not induce development, even if they enter the eggs, which, however, also seems improbable.

But if the atypical spermatozoa play no part in fertilization, what is then their function? We think we can derive an answer from some experiments carried on during the winter of 1914–15 on spermatogenesis in vitro,[10] an answer which is in full harmony with the above quoted results of other investigators.

In rearing the sperm follicles of the moth *Samia cecropia* in tissue-cultures, we found that in the fall the follicles taken from the pupæ finished practically all their normal spermatogenesis and a follicle with apyrene spermatozoa never appeared. But in January and February the results were quite different. The fresh material already contained many degenerating follicles. In the tissue cultures only a very few follicles performed the spermiogenesis, most of them dying after repeated unsuccessful trials to undergo the maturation divisions. These testes, however, already contained many apyrene follicles. Later in February some pupæ were kept in the thermostat for a week. In examining their testes they were found filled with sperm bundles, the great majority of them being apyrene.

In the same experiment it could be shown, further, that the transformation of a sperm-cell into a spermatozoon is caused by the physical condition of the follicle membrane and can be produced artificially to a certain degree. Now one of the main characteristics of the development of the apyrene spermatozoa is the production of caryomerites from the chromosomes and their further degeneration. The same phenomenon has been produced by Conklin[11] in the cleavage cells of *Crepidula* by changing the osmotic conditions of the surroundings. Combining these facts, we reach the conclusion that a definite change in the physical properties of the follicle membrane forces the sperm cells within, physically, to undergo definite atypical changes, which lead to the formation of an apyrene spermium. This process is therefore nothing but the expression of a reaction, necessitated by the physico-chemical properties of the sperm-cell on which the abnormal surroundings act; a reaction produced by abnormal conditions, a teratoma, a lusus naturæ. The typical form of the abnormal sex-cells for a given species is as much necessitated by the specific substratum as the typical form of a plant-gall. The apyrene spermatozoon is a functionless reaction-product.

The results derived from the experiments with intersexual animals are in harmony with this conception derived from the study of tissue cultures. It is well known that the chemical properties of the hemolymph in insects change during metamorphosis in connection with histolysis, and the entire metabolism is put on a different basis, as Weinland[12] proved. In the case of the pupæ of *Samia* it is easy to observe, without going into chemical details, that the blood in old pupæ which produce the atypical spermatozoa has very different properties from those in the young. On the other hand, the work of Steche and Geyer[13] has shown that in the gipsy-moth the chemical characters of the blood are very different in the male and female sex. Hence it might reasonably be expected—tests are going to be made—that in intersexual individuals, where every single character is intermediate to a definite degree between the two sexes, the blood is also different from the normal blood, thus producing in the case of intersexual males those physico-chemical conditions which account for the formation of the apyrene spermatozoa.

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[10] A full account of that piece of work has probably appeared meanwhile in the *Arch. f. Zellforschung*, 1916, under the title: "Einige Versuche zur Spermatogenesis in Vitro." A preliminary notice is found in *Proc. Nat. Ac. Sc.*, I., 1915.

[11] Conklin, E. G., "Experimental Studies on Nuclear and Cell-division in the Eggs of *Crepidula*," *Jour. Ac. Sc.*, 15, 1912.

[12] Weinland, E., "Ueber die Stoffumsetzungen während der Metamorphose der Fleischfliege," *Ztschr. f. Biol.*, 47, 1906.

[13] Geyer, K., "Untersuchungen über die chemische Zusammensetzung der Insectenhaemolymphe," *Ztschr. wiss. Zool.*, 105, 1913.

SCIENCE

Friday, October 20, 1916

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

BOTANY AND ITS ECONOMIC APPLICATIONS[1]

Since our last meeting the Great War has continued to hold chief place in our lives and thoughts, and in various ways, and to a greater or less degree, has influenced our work. In the case of many botany has had for the time being to be set aside, while others have been able to devote only a part of their time to scientific work. On the other hand, it is gratifying to note that some have been able to render helpful service on lines more or less directly connected with their own science. The trained botanist has shown that he may be an eminently adaptable person, capable, after short preparation on special lines, of taking up positions involving scientific investigation of the highest importance from the standpoints of medicine and hygiene.

We have to regret the loss of a promising young Cambridge botanist, Alfred Stanley Marsh, who has made the supreme sacrifice for his country. Happily, in other cases lives have been spared and we are able to welcome their return to the service of botany.

In common with our fellow-botanists throughout the world, we have learned with sorrow of the death of one of the kindliest and most versatile exponents of the science, Count Solms Laubach, whom we have welcomed in years past as a guest of our section.

May I also refer to the recognition recently given by the Royal Society to the

[1] Address of the president of the Botanical Section of the British Association for the Advancement of Science, Section K, Newcastle-on-Tyne, 1916.

services of two of our colonial botanists? Mr. W. H. Maiden, of Sydney, who has done so much in Australia for the development of botany and its applications in his position as government botanist and director of the Botanic Gardens at Sydney, and whose kindness some of us have good cause to remember on the occasion of the visit of this association to Sydney in 1914; and Professor W. H. Pearson, of Cape Town, who is doing useful work of botanical exploration in Southwest Africa.

A little more than two years ago, during the enforced but pleasant leisure of our passage across the Indian Ocean to Australia, I was discussing with our president for the year the possibility of a war with Germany. He was confident that sooner or later it was bound to come. I was doubtful. "But what will prevent it?" asked my companion. "The common sense of the majority," was my reply. He was right and I was wrong, but I think he was only less surprised than myself when next evening we heard, by wireless, rumors of the outbreak of what rapidly developed into the great European war. But even a few weeks later, when Germany was pressing westwards, and the very existence of our Empire was threatened, we hardly began to appreciate what it would mean, and we still talked of the possibility of an International Botanical Congress in 1915.

We know more now, and I need not apologize for considering in my address the part which botanists can take in the near future, especially after the war. For one thing at least is certain, we are two years nearer the end than when it began, and let us see to it that we are not as backward in preparing for post-war as we were for war problems.

Some months ago the various sectional committees received a request to consider what could be done in their respective sections to meet problems which would arise after the war. Your committee met and discussed the matter, with the result that a set of queries was sent round to representative botanists asking that suggestions might be presented for consideration by the committee. A number of suggestions were received of a very varied kind, indicating that in the opinion of many botanists at any rate much might be done to utilize our science and its trained workers in the interests of the state and empire. Your committee decided to arrange for reports to be prepared on several of the more important aspects by members who were specially fitted to discuss these aspects, and these will be presented in the course of the meeting. These reports will, I am convinced, be of great value, and may lead to helpful discusssion; they may also open up the way to useful work.

For my own part, while I might have preferred to consider in my address some subject of more purely botanical interest, I felt that under the circumstances an academic discourse would be out of place, and that I too must endeavor to do something to effect a more cordial understanding between botany and its economic applications.

For many of us this means the breaking of new ground. We have taken up the science because we loved it, and if we have been able to shed any light on its numerous problems the work has brought its own reward. But some of us have on occasion been brought into touch with economic problems, and such must have felt how inadequate was our national equipment for dealing with some of these. In recent years we have made several beginnings, but these beginnings must expand mightily if present and future needs are to be adequately met and if we are determined to make the best use of the material to our hand.

Whether or no we have been living for the past forty years in a fools' paradise, it is certain that our outlook will be widely different after the war, and may the stimulus of a changed environment find us ready to respond!

Sacrifice must be general, and the botanist must do his bit. This need not mean giving up the pursuit of pure science, but it should mean a heavy specialization in those lines of pure science which will help to alleviate the common burden, will render our country and the Empire less dependent on external aid, and knit more closely its component parts.

It may be convenient to consider, so far as they are separable, home and imperial problems.

Without trenching on the domain of economics, we may assume that increased production of foodstuffs, timber and other economic products will be desirable. The question has been raised as to the possibility of increasing at the same time industrial and agricultural development. But as in industry perfection of machinery allows a greater output with a diminished number of hands, so in agriculture and horticulture perfection of the machinery of organization and equipment will have the same result.

There are three factors in which botanists are primarily interested—the plant, the soil, and the worker.

The improvement of the plant from an economic point of view implies the cooperation of the botanist and the plant-breeder. The student of experimental genetics, by directing his work to plants of economic value, is able, with the help of the resources of agriculture and horticulture, to produce forms of greater economic value, kinds best suited to different localities and ranges of climate, those most immune to disease and of the highest food value. Let the practical man formulate the ideal, and then let the scientist be invited to supply it. Much valuable work has been done on these lines, but there is still plenty of scope for the organized Mendelian study of plants of economic importance. It is a very large subject, and we are hoping to hear more about it before we separate.

A minor example occurs to me. Do the prize vegetables which one sees at shows and portrayed in the catalogues represent the best products from an economic point of view; in other words, is the standard of excellence one which considers solely their value as foodstuffs? A chemico-botanical examination would determine at what point increase in size becomes disproportionate to increase in food value, and thus correct the standard from an economic point of view. And, presumably, the various characters which imply greater or less feeding value offer scope for the work of the Mendelian.

The subject of intensive cultivation offers a series of problems which are primarily botanical. It would be a useful piece of investigation to work out the most profitable series which can be grown from year to year with the least expenditure on manures and the minimum of liability to disease. A comparatively small area would suffice for the work.

The introduction of new plants of economic value is within the range of possibility; our repertoire has increased in recent years, but an exhaustive study of food plants and possible food plants for man and stock would doubtless yield good results. It is matter of history that the introduction of the tea plant into further India was the result of observations by Fortune, a botanical collector. The scientific botanist may find pleasant relaxation in the smaller problems of horticulture.

We have heard much lately as to the growing of medicinal plants, and experience would indicate that here is opportunity for investigation, and, unless due care is taken, also danger of waste of time, money and effort. A careful systematic study of species, varieties and races is in some cases desirable in order to ensure the growth of the most productive or valuable plant, as in the case of the Aconites; and such a study might also reveal useful substitutes or additions. Here the cooperation between the scientific worker and the commercial man is imperative. I have recently been interested to hear that the special properties of medicinal plants are to be subjected to experiment on Mendelian lines.

During the past year there has been considerable activity in the collecting of wild specimens of various species of medicinal value, frequently, one fears, involving loss of time and waste of plants, owing to want of botanical or technical knowledge and lack of organization. In this connection a useful piece of botanical work has recently been carried out by Mr. W. W. Smith, of Edinburgh, on the collection of sphagnum for the preparation of surgical dressings. The areas within the Edinburgh district have been mapped and classified so as to indicate their respective values in terms of yield of sphagnum. By the indication of the most suitable areas, the suitability depending on extent of area, density of growth, freedom of admixture of grass or heather, as well as facility of transport and provision of labor, the report is of great economic value. The continuity of supply is an important question, and one which should be borne in mind by collectors of medicinal plants generally. And while it is not the most favorable time to voice the claims of protection of wild plants, one may express the hope that the collector's zeal will be accompanied by discretion.

The advantages arising from a closer cooperation between the practical man and the botanist is illustrated by the research laboratories recently organized by the Royal Horticultural Society at Wisley. Such an institution forms a common meeting-ground for the grower of plants and the botanist. The former sets the problems, and the latter takes them in hand under conditions approaching the ideal and with the advantages of mutual discussion and criticism. Institutions such as these will give ample opportunity to the enthusiastic young botanist who is anxious to embark on work of investigation. The student of plant physiology will find here work of great interest. The grower has perforce gained a great deal of information as to the behavior of his plants under more or less artificial conditions, but he is unable to analyze these conditions, and the cooperation of the physiologist is an invaluable help. Experiments in the growth of plants under the influence of high-tension electricity are at the present time being carried out at Wisley. Such experiments may be conducted anywhere where land and power are available, but it is obviously advantageous that they should be conducted by an expert plant-physiologist versed in scientific method and not directly interested in the result. Dr. Keeble's recent series of lectures on Modern Horticulture at the Royal Institution deal with matter which is full of interest to the botanist. For instance, he shows how the work of continental botanists on the forcing of plants has indicated methods, in some cases simple and inexpensive, which have proved of considerable commercial value, and that there is evidently scope for work in this direction, which, while of interest to the plant-physiologist, may be also of general utility.

The subject of the soil offers problems

to the botanist as well as to the chemist and proto-zoologist. In the plant we are dealing with a living organism, not a machine; and an adequate knowledge of the organism is essential to a proper study of its nutrition and growth. The facility with which a considerable sum of money was raised just before the war to improve the equipment at Rothamsted, where work was being done on these lines, indicates that practical men are ready to come forward with financial help if work which promises to yield results of economic importance is being seriously carried out. And it is significant of the attitude of botanists to such problems that there is only one trained botanist on the staff of this institution.

The study of manures and their effect on the plant should attract the botanist as well as the chemist. In this connection I may refer to Mr. Martin Sutton's recent work at Reading on the effects of radioactive ores and residues on plant life. A series of experiments was carried out in two successive years with various subjects selected for the different character of their produce, and including roots, tubers, bulbs, foliage and fruit. From the immediate point of view of agriculture and horticulture the results were negative; the experiments gave no hope of the successful employment of radium as an aid to either the farmer or the gardener. Speaking generally, the produce from a given area was less when the soil had been treated with pure radium bromide, or various proprietary radioactive fertilizers, than when treated with farmyard manure or a complete fertilizer; while the cost of dressing was very much greater. To quote Mr. Sutton's concluding words:

> The door is still open to the investigator in search of a plant fertilizer which will prove superior to farmyard dung or the many excellent artificial preparations now available.

But though the immediate result was unsatisfactory to the grower, there were several points of interest which would have appealed to the botanist who was watching the course of the experiments, and which, if followed up, might throw light on the effect of radium on plant-life and lead in the end to some useful result. As Mr. Sutton points out, many of the results were "contradictory," while a close examination of the trial notes, together with the records of weights, will furnish highly interesting problems. For instance, there was evidence in some cases that germination was accelerated by the presence of radium, though subsequent growth was retarded; and the fact that in several of the experiments plants dressed with a complete fertilizer in addition to radium have not done so well as those dressed with the fertilizer only may be regarded as corroborating M. Truffaut's suggestion that radium might possess the power of releasing additional nitrogen in the soil for the use of plants, and that the plants in question were suffering from an excess of nitrogen. Certain remarkable variations between the duplicate unmanured control plots in several of the experiments led to the suggestion that radium emanations may have some effect, apparently a beneficial one. I have quoted these experiments as an example of a case where the cooperation of the botanist and the practical man might lead to useful results, and at the same time afford work of much interest to the botanist.

As an introduction to such work university professors might encourage their advanced students to spend their long vacation in a large nursery or botanic garden where experimental work is done.

As regards the worker in agriculture and horticulture, how can the botanist help? Apart from well-staffed and well-equipped schools of agriculture and horticulture.

which require the botanist's assistance, a wider dissemination of the botanist would be advantageous. Properly trained botanists distributed through the country with their eyes open might be a valuable asset in the improvement of production; botanist and cultivator might be mutually helpful; the former would meet problems at first hand, and the latter should be encouraged by the cooperation. A kind of first-aid class suggests itself, run by a teacher with a good elementary knowledge of botany, upon which has been erected a general knowledge of horticultural operations. This would afford a vocation for students of scientific bent who can not spare the time for a long university course. Some of us may remember the courses arranged by various County Councils thirty years or so ago, financed by the whiskey money, out of which have grown some useful permanent educational institutions. But these courses were often barren of result, owing partly to insufficient "sympathy" between the lecturer and his audience. A young man fresh from the university who was waiting for a more permanent job was brought into touch with the practical man in the lecture hall, and the contact was, so to speak, not good. Between the two was a gulf across which the lecturer shouted, and his words often conveyed little meaning to those on the other side. A great deal of money must have been spent with incommensurate results.

On the other hand, we must be careful to work economically and not wear out high-class tools on rough work. I think there is some danger of this in connection with certain courses in horticulture for women. Girls who have had a good general education enter, at the age of seventeen or eighteen, on a course of study, lasting for two or three years, of horticultural methods and the kindred sciences. So far, good; but after all this training the finished product should aspire to something more than market gardening in competition with the man who left school at twelve or fourteen, has learned his business practically, and has a much lower standard of living.

The utilization of waste lands is a big subject and trenches on the domain of economics. But important botanical problems are involved and careful ecological study will prepare the way for serious experimental work. The study of the growth of plants in alien situations is fraught with so many surprises and apparent contradictions that successful results may be looked for in most unlikely situations. I remember a striking instance near Lake Tarawera, in the North Island of New Zealand. The area in question had been completely devastated in the great eruption of Mount Tarawera in 1886, the ground being covered with ash to a depth of several feet. When I saw it two years ago the vegetation of a considerable area was almost purely central European. The trees were poplar, *Robinia* and elder, with an undergrowth of dog-rose, bramble, etc. I was not able to find out the recent history of the locality and there were very few signs of habitation, but it was not the kind of vegetation one would expect to find growing so naturally and freely in such a locality. But the subject of utilization of waste lands will occupy us later.

The study of the diseases to which plants are liable, and their prevention and cure, offers a wide and increasing field for inquiry, and demands a larger supply of trained workers and a more definite and special system of training. For the study of those which are due to fungi it is obviously essential that a thorough general knowledge of fungi and laboratory methods should be acquired, preferably at some Pathological Institution which would also

be in touch with the cultivator and naturally approached by those requiring advice and help in connection with disease, on the same principle that a medical school is attached to a hospital. An important part of the training should be the study of the disease in the field and the conditions under which it arises and flourishes. From the point of view of mycology much useful scientific work remains to be done on the life history of the fungi which are or may be the causes of disease. The study of preventive methods must obviously be carried out in the field, and, while these are mainly mechanical processes, they need careful supervision; the question of the subsequent gathering and disposal of a crop must not be overlooked. Experiments in the use of dust instead of spray as a preventive of fungous and insect attack have recently been carried out in America. Other plant diseases afford problems for the physiologist, who is a necessary part of the equipment of the pathological institute.

The anatomical and chemical study of timbers might with advantage occupy a greater number of workers. The matter is of great economic importance. Questions of identity are continually arising, and in the present vague state of our knowledge it is often difficult or impossible to give a satisfactory answer. Samples of timber are put on the market shipped, say, from West Africa under some general name such as mahogany; the importer does not supply leaves and flowers for purpose of identification, and in the present incomplete state of our knowledge it is often impossible to make more than a vague attempt at determination. Or a merchant brings a sample which has been sent from X as Y, which it obviously is not; but what is it, whence does it probably come, and what supply of it is likely to be forthcoming? These are questions which it would be useful to be able to answer with some greater approach to accuracy than at present. And it should be the work of definitely trained persons. I recall a sample of wood which some months ago, coming from a government department, went the round of the various institutions which were at all likely to be able to supply the required information as to its identity. It should have been matter of common knowledge where to apply, with at the same time reasonable certainty of obtaining the information required.

It is possible also that a more systematic study of minute structure would help to solve questions of affinity. A chemical study has proved of value in the discrimination of the species of *Eucalyptus* in Australia.

Apart from cooperation between the botanist and the practical or commercial man, there is need for coordination between workers. I give the following incident from real life. At the meeting of an advisory committee the head of a certain institution stated that he had set one of his staff to work at a certain disease which was then under discussion, but had learned shortly after that a student at another institution was engaged on the same piece of work. A conference led to a useful division, one of the workers to study the life history of the organism in the laboratory, the other to work at conditions of life, etc., in the field. But it also transpired that another institution, as well as another independent worker, was engaged on the same problem, and while it was suggested that in one case cooperation might be invited, it was deemed inadvisable to approach the other. The problem in this case was not one of such special difficulty as to require so much attention, and even if it had been some coordination between the various working units would have been helpful. Similar instances will occur to you. The measure of efficiency of our science should be the sum of the efficiency of its workers. It should

be possible to devise some means for informing fellow-workers as to the piece of work in hand or proposed to be undertaken, and thus, on the one hand, to avoid wasteful expenditure of time and effort, and not infrequently the hurried publication of incomplete results, and on the other, to ensure where practicable, the benefits of cooperation.

The various illustrative suggestions which I have made would imply a close cooperation between the schools of botany and colleges and institutions of agriculture, horticulture and forestry; to pass from the former to one or other of the latter for special work or training should be a natural thing. While, on the one hand, a university course is not an essential preliminary to the study of one or other of the applied branches, the advantage of a broad, general training in the principles of the science can not be gainsaid. The establishment of professorships, readerships or lectureships in economic botany at the university would supply a useful link between the pure and applied science, while research fellowships or scholarships would be an incentive to investigation.

There is the wider question of a rapprochement between the man of science and the commercial man. Its desirability is obvious, and the advantages would be mutual; on the one hand, it would secure the spread and application of the results of research, and on the other hand, the man of science would be directed to economic problems of which otherwise he might not become cognizant. The closer association between the academic institution and those devoted to the application of the science would be a step in this direction.

Our British possessions, especially within the tropics, contain a wealth of material of economic value which has been only partially explored. One of the first needs is a tabulation of the material. In the important series of Colonial floras incepted by Sir Joseph Hooker, and published under the auspices of Kew, lies the foundation for further work. Consider, for instance, the "Flora of Tropical Africa," now rapidly near completion. This is a careful and, so far as possible with the material at hand, critical descriptive catalogue of the plants from tropical Africa which are preserved in the great British and European herbaria. The work has been done by men with considerable training in systematic work, but who know nothing at first hand of the country, the vegetation of which they are cataloguing. Such a "Flora" must be regarded as a basis for further work. Its study will indicate botanical areas and their characteristics, and suggest what areas are likely to prove of greater or less economic value, and on what special lines. It will also indicate the lines on which areas may be mapped out for more detailed botanical exploration. That this is necessary is obvious to any botanist who has used such a work. A large proportion of the species, some of which may, on further investigation, prove to be of economic value, are known only from a single incomplete fragment. Others, for instance, which may be of known economic value, doubtless exist over much larger areas and in much greater quantity than would appear from the "Flora." The reason of these shortcomings is equally obvious. The collections on which the work is based are largely the result of voluntary effort employed more or less spasmodically. The explorer working out some new route, who brings what he can conveniently carry to illustrate the plant products of the new country; the government official or his wife, working during their brief leisure or collecting on the track between their different stations: the missionary or soldier, with a penchant for natural history; to these and similar persons we are largely in-

debted for additions to our knowledge of the plant-life. Advantage has sometimes been taken of a government expedition to which a medical man with a knowledge of or taste for natural history, or, in rare cases, a trained botanist, has been attached.

The specimens brought home by the amateur collector often leave much to be desired, and little or no information is given as to the precise locality or the nature of the locality, the habit of the plant, or other items of importance or interest. There may be indications that the plant is of economic value, but no information as to whether it is rare or plentiful, local or occurring over a wide area.

Samples of wood are often brought, but generally without any means of identification except a native name; and it must be borne in mind that native names are apt to be misleading; they may be invented on the spur of the moment to satisfy the white man's craving for information, or when genuine are often applied to more than one species.

A large proportion of the more extensive collections are due to German enterprise, and the best representation of this work is naturally to be found in Germany, though it is only fair to state that the German botanists have been generous in lending material for work or comparison. The botanical investigation of German East Africa and the Cameroons has been carried out by well-trained botanists and collectors, and the results of their work published both from botanical and economic points of view. I may refer to the large volume on German East Africa, which contains not only a general account of the vegetation and a systematic list of the genera and species comprising the flora, but also an account of the plants of economic value classified according to their uses. The exploration of the Belgian Congo has been seriously undertaken by the Belgian government, and a number of large and extensively illustrated botanical memoirs have been issued. Some of us may be familiar with the fine Congo Museum near Brussels.

It is time that pioneer work gave place to systematic botanical exploration of our tropical possessions and the preparation of handy working floras and economic handbooks. Work of botanical exploration should be full of interest to the young botanist. But if he is to make the best use of time and opportunity he must have had a proper course of training. After completing his general botanical course, which should naturally include an introduction to the principles of classification, he should work for a time in a large herbarium and thus acquire a knowledge of the details of systematic work and also of the general outlines of the flora of the area which he is to visit later. He should then be given a definite piece of work in the botanical survey of the area. From the collated results of such work convenient handbooks on the botanical resources of regions open to British enterprise could be compiled. There will be plenty of work for the systematist who can not leave home. The ultimate elaboration of the floristic work must be done in the herbarium with its associated library. There is also need of a careful monographic study of genera of economic value which would be best done by the experienced systematist at home, given a plentiful supply of carefully collected and annotated material. An example of such is the systematic account of the species of *Sanseviera* by Mr. N. E. Brown, recently issued at Kew. Closely allied, or varieties of one and the same, species may differ greatly in economic value, and the work of the monographer is to discover and diaguose these different forms and elucidate them for the benefit of the worker in the field.

If we are to make the best use of our resources, botanical research stations in dif-

ferent parts of the empire, adequately equipped and under the charge of a capable trained botanist, are a prime necessity. We seem to have been singularly unfortunate, not to say stupid, in the management of some of our tropical stations and botanical establishments.

The island of Jamaica is one of the oldest of our tropical possessions. It is easy of access, has a remarkably rich and varied flora, a fine climate and affords easy access to positions of widely differing altitude. It is interesting to imagine what Germany would have made of it as a station for botanical work if she had occupied it for a few years. The most recent account of the flora which pretends to completeness is by Hans Sloane, whose work antedates the Linnæan era. A flora as complete as available material will allow is now in course of preparation in this country, but the more recent material on which it is based is due to American effort. Comparatively recently a mycologist has been appointed, but there is no government botanist to initiate botanical exploration or experimental work or to advise on matters of botanical interest. A botanical station ideal for experimental work in tropical botanical problems is a mere appendage of a Department of Agriculture, the director of which is a chemist.

A botanical station for research to be effective must be under the supervision of a well-trained botanist with administrative capacity, who must have at his disposal a well-equipped laboratory and ground for experimental work. He must not be expected to make his station pay its way by selling produce or distributing seedlings and the like; a botanical station is not a market-garden. The director will be ready to give help and advice on questions of a botanical nature arising locally, and he will be on the lookout for local problems which may afford items of botanical research to visiting students. Means must be adopted to attract the research student, aided, if necessary, by research scholarships from home. The station should have sufficient imperial support to avoid the hampering of its utility by local prejudice or ignorance. The permanent staff should include a mycologist and a skilled gardener.

The botanical station does not preclude the separate existence of an agricultural station, but the scope of each must be clearly defined, and under normal conditions the two would be mutually helpful. Nor should the botanical station be responsible for work of forestry, though forestry may supply problems of interest and importance for its consideration.

Finally, I should like to suggest the holding of an imperial botanical congress at which matters of general and special interest might be discussed. The visit of the British Association to Australia was, I think, helpful to the Australian botanists; it was certainly very helpful and of the greatest interest to those coming from home. Many of the addresses and papers were of considerable interest and value, but of greater value was the opportunity of meeting with one's fellow-workers in different fields, of conversation, discussion and interchange of ideas, the better realization of one's limited outlook and the stimulus of new associations. A meeting which brought together home botanists and botanical representatives from oversea portions of our empire to discuss methods of better utilizing our vast resources would be of great interest and supremely helpful. Let us transfer to peace purposes some of the magnificent enthusiasm which has flowed homewards for the defence of the empire in war.

In this brief address I have tried, however imperfectly, to indicate some lines on which botanists may render useful service

to the community. To a large extent it means the further development and extension of existing facilities, added to an organized cooperation between botanists themselves and between botanists and the practical and commercial man: this will include an efficient, systematic cataloguing of work done and in progress. We do not propose to hand over all our best botanists to the applied branches and to starve pure research, but our aim should be to find a useful career for an increasing number of well-trained botanists and to ensure that our country and empire shall make the best use of the results of our research. Incidentally there will be an increased demand for the teaching botanist, for he will be responsible for laying the foundations.

Complaint has been made in the past that there were not enough openings for the trained botanist; but if the responsibilities and opportunities of the science are realized we may say, rather, "Truly the harvest is plentiful, but the laborers are few." Botany is the *alma mater* of the applied sciences, agriculture, horticulture, forestry, and others; but the *alma mater* who is to receive the due affection and respect of her offspring must realize and live up to her responsibilities.

A. B. Rendle

CHARLES SMITH PROSSER

The "country boys" of New York state never had a fair chance for a higher education until Cornell University was established with its state and government subsidies. The early days of that institution gave adequate proof of this and as the years have passed the successful careers of these boys of New York and Cornell have been eloquent testimony to this aid. True for many branches of human knowledge and practise, this statement is eminently applicable to the earlier graduates in the science of geology. Dr. Prosser, whose sudden and unexplained death on September 11 has been widely noticed in the press, was one of these country boys. Born in 1860 in Columbus, a little hamlet of Chenango County, N. Y., the son of a farmer of slight substance, and grandson of one of the early settlers of the region, the simple surroundings of his boyhood were of a kind to give unconscious direction to his maturing life. His home lay back on the hills which bound the Unadilla River on its way south to join the Susquehanna, and its outcropping rocks were filled with things which, to his attentive eye and naturally reflective mind, must have awakened many questionings. A farmer's boy in a stony country where fields have to be picked over regularly after the spring plowing, is pretty sure to either love or hate the rocks. A disposing mind led this farmer's boy to wish to know more about them. When the country school a few miles away at Brookfield could give him no more, he took the helping hand which Cornell held out and entered there in 1879. And it was to be his fortune in after life, when fully equipped, to return to his home valley and, under the auspices of his state geological survey, to apply his well-trained mind to the solution of its geological problems. So excellently did he habilitate himself in college that after his graduation as bachelor of science in 1883 he received the first award of the Cornell fellowship in natural history and then for three years was instructor in the department of geology. From there he went to Washington as an aid to the late Lester F. Ward, in the paleobotanical work of the U. S. Geological Survey. It was then I first came to know him while he was engaged in collecting fossil plants, and then, as always afterwards, I found him conscientious and earnest, though obviously not at that time particularly enthusiastic over the work that had been allotted to him. His experience as a teacher seemed to draw him toward that work again and he left Washington in 1894, though without dissolving his effective connection with the federal survey, to become professor of natural history in Washburn College, Topeka. There are active geologists to-day, who were his students there, but the major result of his stay in Kansas is, I

should say, the opening it afforded for his researches on the late paleozoic rocks of that state, problems that he followed not only while there, but to which he returned in later years. His work on the Carboniferous and Permian of Kansas and eastern Nebraska, some of it undertaken under the auspices of the Kansas University Geological Survey, was of unquestionably high value, much of it of fundamental importance. But it was his success as a teacher which gave him in 1894 a call to Union University at Schenectady, N. Y., and as it was a call which brought him back home and to the rocks of New York out of which he grew, he accepted it with alacrity. Union was then venturing on the experiment of establishing a separate department of geology, and her experiment was successful enough, as some admirable geologists and paleontologists and many other graduates of Union under Prosser's régime, stand to-day to testify. It was while at Schenectady that Professor Prosser entered upon his alliance with the New York Geological Survey and in this association accomplished a large amount of useful analytical work on its stratigraphical problems. His papers published during this period of his life were notable, and cover portions of eastern and central New York; the Mohawk Valley and the vicinity of Schenectady, the Helderberg Mountains, the Unadilla, the Oneonta, the Catskill and other regions—all characterized by his peculiarly exact and detailed procedure.

In his last year at Schenectady he was made chief of the Appalachian division of the Maryland geological survey and thereafter for several years his summers were spent in field work on the paleozoic rocks of Maryland, Pennsylvania and West Virginia.

In 1899 Professor Edward Orton, Sr., the distinguished state geologist of Ohio, former president of the State University, educated in Albany and in his later years allied with the official work of New York, perceiving the advance of the years, fastened on Prosser as the man to succeed him in the professorship of geology in the State University of Ohio at Columbus, and thither Dr. Prosser went as associate professor of historical geology. In 1901 he was made head of the department. There he remained till his death—seventeen years. Professor Orton died not long after Prosser's arrival in Columbus and I think the initiate was in some ways embarrassed by the sudden loss of the man who otherwise would have been his wise guide at the beginning of his new undertaking. For some time after settling in Columbus Dr. Prosser maintained his official and intimate relations with New York, but gradually the problems nearer to him invited his attention and a natural loyalty to the state of his adoption and his official connection with its survey, together with the requirements of his college work, absorbed his energies. In this period, however, he was able to give much time and to do much valuable work on the paleozoic rocks of Maryland under the auspices of the official survey of that state, now published as a part of the admirable series of reports of that organization. Of his many contributions to the geology of Ohio which have been published during his career at Columbus, most of them themes of stratigraphic determination and correlation, all bear the impress of his cautious mode and detailed analysis which make them practically final for the fields they cover.

It will be the work of another, I trust, to set forth adequately the merit of Dr. Prosser's many contributions to the science of geology, and to record the strong uplifting influence he had upon his pupils. There stand to his credit men of great worth in this science in American universities who were moulded by his hand, but for each one of these trained and proficient men there are scores who have felt the inspiration of his lectures, have been uplifted by his unstudied but unfailing courtesy and thoughtfulness and have been inspired by their association with him in the field. His courses at the Ohio State University had greatly grown in popularity and efficiency as his students were made to perceive the high cultural value of his science, wholly apart from any of its commercial phases.

But while I am not able fully to speak on this phase of his work except as I have learned

it from others, I desire to add a few words about the man as I have found him through the acquaintance of many years.

There never was a more loyal, a more devoted, a more sensitive spirit. His attitude of mind was puritanic in its simplicity and in its practises, and, left to himself, he could never suspect another of indirectness or duplicity—a quality of which he contained not a grain. When confronted by the broader bearings of his science and the natural sequences of its greater propositions, he held himself somewhat carefully aloof; it seemed as though the youthful bendings of the twig inclined him away from paths he would not follow. Yet this simplicity of heart, which would not let him go far a-field, also made him extraordinarily conscientious in his scientific work. It would not be fair to him to say that he had a genius for details, but it would be eminently right to assert that he sought intimately and faithfully for the exact construction of every observation he made so far as that had to do with the theme in hand. This mental method led him to precision of manner, gave him a certain formality which was seldom dismissed under the most informal circumstances. Dr. Prosser's physical address was very pleasing, but his natural reticence, his precision of thought and his fear of an inexact or loose statement made him a hesitant speaker, though a speaker who was always punctiliously guarding a jewel of highest worth—the truth. Added to this trait, which we may well count a virtue, was his absolute fealty to, first, his science, then to his friends. For those whom he knew to be his friends no sacrifice was too great, no defense too vigorous; from them no defection was thinkable. The word of personal criticism seldom passed his lips. If he had suffered an injustice, or an inadequate commentary, it was dismissed with a ripple of a deprecating smile, as though in pity of himself. His determinations of fact he was prepared to defend and to claim his title in them, and his high-strung temperament made him revolt when he saw the credit for his determinations complacently or in ignorance absorbed by another. To this he would not become inured, as almost every investigator in science must; it was to him a rape of his golden fleece.

Out of the quarry stones of his home land he had laboriously built the house of his desires; few know with what struggles against untoward circumstance, with what patient tugging at an unspoken load with which a churlish fate had saddled him. He did build the house of his spirit's desire and has left behind many who have seen far enough within its doors to honor his accomplishment, lament his sorrows and his unhappy end, and to cherish his memory.

Professor Prosser was buried in the Rural Cemetery at Albany where the members of the New York Geological Survey and representatives of Union University faculty and corporation gathered to pay their last respects to the poor suffocated body which had enshrined so pure a spirit.

John M. Clarke

THE NATIONAL RESEARCH COUNCIL

The first meeting of the National Research Council was held in New York City on September 20, 1916. Dr. M. I. Pupin, as temporary chairman, called the meeting to order at 3.10 P.M., and directed a roll-call of the members of the council. There were present the following members: Messrs. Carty, Dunn, Goss, Hale, Herschel, Holmes, Keen, Manning, Marvin, Millikan, Noyes, Pickering, Pupin, Rand, Skinner, Squier, Stratton, Swasey and Vaughan.

The temporary chairman then called for nominations for permanent chairman. Dr. George E. Hale was nominated and unanimously elected. Dr. Hale then took the chair and presided for the remainder of the meeting. Dr. Charles D. Walcott was elected first vice-chairman, and Mr. Gano Dunn second vice-chairman.

Dr. Hale, as chairman of the organizing committee of the council, first announced an agreement between the National Academy of Sciences and the Engineering Foundation by which the foundation has placed its funds at the disposal of the council for a period of one

year and has given the services of its secretary, Dr. Cary T. Hutchinson, to the National Research Council, to serve as its secretary. Dr. Hale announced that in accordance with this agreement the National Academy of Sciences has appointed Dr. Hutchinson, secretary of the National Research Council. Dr. Hutchinson was present and acted as secretary to the meeting.

The chairman then gave an extended account of the work done by the organizing committee during the summer months, dwelling particularly upon his trip to England and France, and upon the results that have been reached there by similar organizations of the men of science.

At the conclusion of the chairman's remarks the organization of the council was discussed; and the motion was made that an executive committee, to consist of a chairman and nine members, be appointed by the chair, with the chairman of the council and president of the academy as additional members ex-officiis, this committee to have full authority in the interim between meetings of the council to carry out the purposes described in the preliminary report of the organizing committee (published in the August 25 number of SCIENCE), it being understood that, in carrying out the general plan of work of the council as there outlined, the executive committee shall not be limited to a narrow interpretation of the objects, but shall have full power to undertake similar or related work, even though not specifically included in that report. This motion was carried unanimously.

The chairman then requested the members of the council to express their views on the proposed work of the council and in particular to make suggestions covering definite lines of work that might fall within the sphere of activity of the council. A discussion then took place, participated in by nearly all the members of the council.

Dr. Millikan then presented a preliminary report from the committee on the Newlands Bill, which provides for the appropriation by the government of $15,000 annually to each of the states, to be applied to research in engineering and applied science. After discussion the report was referred back to the committee for further consideration, with instructions that it be then referred to the executive committee of the Research Council.

A recess was then taken to enable the members of the council to attend a dinner given in their honor at the University Club by Dr. Hale. The council was again called to order at 9.30 P.M. by the chairman. The members present then discussed special features of the work that the council might undertake.

The chairman announced the appointment of the following six members of the executive committee: Messrs. J. J. Carty, E. G. Conklin, Gano Dunn, A. A. Noyes, M. I. Pupin and V. C. Vaughan. He stated that the other four members would be appointed after further consideration. A vote of thanks to the chairman for his invaluable services was unanimously adopted. After further general discussion the council adjourned.

Two meetings of the executive committee were held in New York on September 21 and 29, 1916. At these meetings business was transacted as follows:

Dr. J. J. Carty was elected chairman; and Dr. C. T. Hutchinson, secretary of the committee. It was voted that the terms of the present members of the research council and of the executive committee be deemed to expire on January 1, 1918.

The following resolution was adopted, expressing the general policy to be followed by the council in the promotion of research.

Resolved, that the efforts of the Research Council shall be uniformly directed to the encouragement of individual initiative in research work, and that cooperation and organization, as understood by the Research Council, shall not be deemed to involve restrictions or limitations of any kind to be placed upon research workers.

The following resolution was adopted, inviting the American Association for the Advancement of Science to cooperate with the Research Council.

Resolved, that the American Association for the Advancement of Science be informed that the National Research Council has been organized by the National Academy of Sciences at the request of

the President of the United States for the purpose of bringing into cooperation existing governmental, educational, industrial and other research organizations, with the object of encouraging the investigation of natural phenomena, the increased use of scientific research in the development of American industries, the employment of scientific methods in strengthening the national defense, and such other applications of science as will promote the national security and welfare, and that the association, which has itself established the Committee of One Hundred on Research, be invited to cooperate with the Research Council in the promotion of research, and that to this end it be asked to appoint a committee of three to meet with a similar committee of the Research Council to consider how much cooperation can be made most effective.

As members of this committee on behalf of the Research Council, Dr. Welch, president of the Academy, and Messrs. Conklin and Noyes were appointed.

The following committees were also appointed:

A Committee on Research in Educational Institutions, consisting of G. E. Hale, chairman, J. S. Ames, R. H. Chittenden, J. M. Coulter, G. N. Lewis, G. H. Parker, Harold Penders, C. R. Van Hise and F. J. E. Woodbridge; this committee to consider general plans for the promotion of research in educational institutions, and to have power to arrange for local research committees in each institution.

A Committee on the Promotion of Industrial Research, Dr. J. J. Carty, chairman, with functions in its field somewhat similar to those of the Committee on Research in Educational Institutions.

A Committee on a National Census of Research, Dr. Stratton, chairman, to prepare a national census of equipment for research, of the men engaged in it, and of the lines of investigation pursued in cooperating government bureaus, educational institutions, research foundations and industrial research laboratories.

Mr. Dunn reported that the United Engineering Society had granted for a period of one year from October 1, 1916, free of assessment, two rooms in its building for the use of the Engineering Foundation, to serve as the New York Office of the National Research Council, these rooms being those recently vacated by the Naval Consulting Board.

It was voted to recommend to the president of the academy that Marston T. Bogert, of Columbia University, Russell H. Chittenden, of Yale University, and Raymond Pearl, of the Maine Experiment Station, be invited to become members of the council.

It was voted that joint committees on research in various branches of science be formed in cooperation with the corresponding national scientific societies.

A more complete account of the actions and discussions of the Research Council and of its executive committee will be found in the October number of the *Proceedings* of the National Academy of Sciences.

CARY T. HUTCHINSON,
Secretary

ORGANIZATION OF THE NATIONAL RESEARCH COUNCIL

THE National Research Council was formally organized at a meeting held in New York City on September 20, 1916. It was established by the National Academy of Sciences at the request of the President of the United States. The members of this council have been appointed by the president of the academy, after consultation with the presidents of leading national scientific societies. The representatives of the government were appointed by the President of the United States. The council is to be gradually enlarged by the addition of new members who are to serve as chairman of important committees or who are otherwise to engage in some special capacity in the work of the council.

The organization of the council is at present as follows:

OFFICERS AND EXECUTIVE COMMITTEE

Chairman, George E. Hale.

Vice-chairmen, Charles D. Walcott; Gano Dunn.

Secretary, Cary T. Hutchinson.

Executive Committee, John J. Carty (chairman), William H. Welch (ex-officio), George E. Hale (ex-officio), Edwin G. Conklin, Gano Dunn, Arthur A.

Noyes, Raymond Pearl, Michael I. Pupin, S. W. Stratton, V. C. Vaughan, and others to be appointed.

MEMBERS

DR. L. H. BAEKELAND, Yonkers, N. Y.

DR. MARSTON T. BOGERT, professor of organic chemistry, Columbia University.

DR. JOHN A. BRASHEAR, Allegheny, Pa.

DR. JOHN J. CARTY, chief engineer, American Telephone & Telegraph Co.

DR. RUSSELL H. CHITTENDEN, director, Sheffield Scientific School, Yale University.

DR. EDWIN G. CONKLIN, professor of zoology, Princeton University.

DR. JOHN M. COULTER, professor of botany, University of Chicago.

MAJOR GENERAL WILLIAM CROZIER, chief of ordnance, U. S. A.

MR. GANO DUNN, president, The J. G. White Engineering Corporation.

DR. SIMON FLEXNER, director, Rockefeller Institute for Medical Research.

BRIGADIER GENERAL WILLIAM CRAWFORD GORGAS, surgeon general, U. S. A.

DR. W. F. M. GOSS, dean of engineering, University of Illinois.

DR. GEORGE E. HALE, director, Mt. Wilson Solar Observatory.

MR. CLEMENS HERSCHEL, president, American Society of Civil Engineers.

DR. WILLIAM H. HOLMES, curator, United States National Museum.

DR. W. W. KEEN, president, American Philosophical Society.

MR. VAN H. MANNING, director, Bureau of Mines.

PROFESSOR CHARLES F. MARVIN, chief, United States Weather Bureau.

PROFESSOR A. A. MICHELSON, director, Ryerson Physical Laboratory, University of Chicago.

DR. ROBERT A. MILLIKAN, professor of physics, University of Chicago.

DR. ARTHUR A. NOYES, director, research laboratory of physical chemistry, Massachusetts Institute of Technology.

DR. RAYMOND PEARL, director, Maine Agricultural Experiment Station.

PROFESSOR E. C. PICKERING, director, Harvard College Observatory.

DR. MICHAEL I. PUPIN, professor of electro-mechanics, Columbia University.

MR. CHARLES F. RAND, president, United Engineering Society.

DR. THEODORE W. RICHARDS, director, Walcott Gibbs Memorial Laboratory, Harvard University.

MR. C. E. SKINNER, director, research laboratory, Westinghouse Electric & Manufacturing Co.

LIEUTENANT COLONEL GEORGE O. SQUIER, chief of aviation, U. S. A.

DR. S. W. STRATTON, director, Bureau of Standards.

MR. AMBROSE SWASEY, Cleveland, Ohio.

CHIEF CONSTRUCTOR DAVID W. TAYLOR, U. S. Navy.

DR. ELIHU THOMSON, Swampscott, Mass.

DR. C. R. VAN HISE, president, American Association for the Advancement of Science.

DR. VICTOR C. VAUGHAN, director, medical research laboratory, University of Michigan.

DR. CHARLES D. WALCOTT, secretary, Smithsonian Institution.

DR. WILLIAM H. WELCH, president, National Academy of Sciences.

DR. W. R. WHITNEY, director, research laboratory, General Electric Co.

SCIENTIFIC NOTES AND NEWS

ON the occasion of the celebration of the 150th anniversary of Rutgers College the degree of doctor of science was conferred on Dr. J. L. R. Morgan, of the class of '92, professor of physical chemistry in Columbia University; on Dr. Peter Cooper Hewitt, of New York City, and on Chuzaburo Shiba, professor of mechanical engineering in the Imperial University of Tokyo.

THE Italian Society of Sciences has awarded its gold medal for 1915 to Professor P. Calapso, of the University of Messina, for his researches in geometry.

EDWARD RAY WEIDLEIN has been appointed associate director of the Mellon Institute of Industrial Research of the University of Pittsburgh. Mr. Weidlein has held an industrial fellowship since 1910, and during the past four years has been in active charge of the hydrometallurgical investigations of the institute.

MR. VICTOR A. BEEDE, assistant state forester of New Hampshire, has been elected executive secretary of the New York State Forestry Association, with headquarters at the Chamber of Commerce Building, Syracuse, N. Y.

At its meeting held on October 11, the Rumford Committee of the American Academy of Arts and Sciences appropriated the sum of $300 to Professor J. A. Parkhurst, of the Yerkes Observatory, in aid of his investigation on the determination of the photovisual scale of stellar magnitudes.

We learn from the *Journal* of the American Medical Association that the governor of Minnesota has appointed a commission composed of the following members to investigate and report on the need of additional health safeguards for the citizens of the state: Dr. E. P. Lyon, dean of the University of Minnesota Medical School, Minneapolis; C. G. Schultz, superintendent of the state department of education; William F. Houk, state labor commissioner; C. J. Swendsen, chairman, state board of control; Senator L. E. Potter, Springfield; Drs. Arthur T. Laird, superintendent of the Nopeming Sanatorium; Louis B. Wilson, Rochester; Warren L. Beebe, president, and Ignatius J. Murphy, St. Paul, executive secretary of the Minnesota Public Health Association. At the meeting for organization, held September 20, in St. Paul, Dr. E. P. Lyon was elected chairman, and Dr. Ignatius J. Murphy, secretary of the commission.

The motion picture film, "How Life Begins," was presented on October 6, before the New York Association of Biology Teachers. This picture has been perfected by George E. Stone, A.B., of Berkeley, Cal., in collaboration with Dr. J. A. Long, assistant professor of embryology of the University of California. It embodies many interesting features in the life-history of the different classes of animals.

At its regular fall meeting on September 27, the Elisha Mitchell Scientific Society elected the following officers for the coming year: *President,* T. F. Hickerson; *vice-president,* J. G. Beard; recording-secretary, J. W. Lasley, Jr. The following were elected to associate membership in the society: R. P. Brooks, J. W. Hale, J. W. Scott, C. W. Higgins, A. C. Forney, W. T. Harper, Geo. Slover, M. M. Williams, and S. H. Hobbs, Jr. At the first meeting for discussion, on October 10, two papers were presented to the society by Dr. A. S. Wheeler on "The Second International Chemical Exposition," and by J. W. Lasley, Jr., on "Some Elementary Vector Equations."

The Cartwright lectures of the Association of the Alumni of the College of Physicians and Surgeons, Columbia University, will be given on October 24 and 25, at 5 o'clock, by Dr. Richard M. Pearce, Jr., professor of research medicine of the John Herr Musser Department of Research Medicine, University of Pennsylvania. His subject will be "The Spleen in Its Relation to Blood Destruction and Regeneration."

The twelfth course of Harvey Society lectures will begin on October 14 and close on April 7. The lectures will be given on Saturday evenings in the New York Academy of Medicine. The following lectures are announced: October 14—Professor J. S. Haldane, "The New Physiology"; November 4—Dr. F. M. Allen, "The Rôle of Fat in Diabetes"; November 25—Dr. Paul A. Lewis, "Chemo-Therapy in Tuberculosis"; December 16—Professor Henry H. Donaldson, "Growth Changes in the Mammalian Nervous System"; January 13—Professor E. V. McCollum, "The Supplementary Dietary Relationships Among Our Natural Foodstuffs"; February 3—Professor J. W. Jobling, "The Influence of Non-Specific Substances on Infections"; February 24—Professor John R. Murlin, "The Metabolism of Mother and Offspring before and after Parturition"; March 17—Professor Francis W. Peabody, "Cardiac Dyspnea"; April 7—Professor W. H. Howell, "The Coagulation of the Blood."

Professor J. Norman Collie, director of the chemical laboratories of University College, London, gave a lecture on October 31, on "The Scientific Work of Sir William Ramsay."

October 11 was observed by the Chicago Medical Society as Dr. John B. Murphy me-

morial night. The following were announced as speakers: Drs. George W. Crile, Cleveland; C. A. L. Reed, Cincinnati; Frank Billings, L. L. McArthur, E. Wyllys Andrews, D. A. K. Steele, A. D. Bevan, W. E. Quine, A. J. Ochsner, Jacob Frank and W. A. Evans.

A bronze bust of Dr. Nicholas Senn has been presented to the Wisconsin Historical Museum, Madison, by Dr. Emanuel J. Senn, of Chicago. Dr. Senn began his practise as a country practitioner near Fond du Lac in 1869.

Dr. Levi Leonard Conant, head of the department of mathematics at the Worcester Polytechnic Institute, was killed by an automobile truck on October 11. Professor Conant was born in 1857. He was known for his work on primitive number concepts, the history of mathematical notation and the theory of functions and of graphs.

Don José Echegaray, professor of mathematical physics in the University of Madrid, and distinguished also as a poet and dramatic author, died on September 15, aged eighty-three years.

Dr. V. von Czerny, professor of surgery at the University of Heidelberg since 1877 and chief of the cancer research hospital there, has died, aged seventy-four years.

The death is also announced of A. Magnan, one of the leading alienists of France.

Mr. R. J. L. Guppy, known for his work on the geology of Trinidad and other West Indian Islands, his died at the age of eighty years.

The death in Munich, on June 22, of Mr. Gustav Mann, is announced in *Nature*. Mr. Mann, who was in his eighty-first year, was known for his botanical work in Africa and India.

Mr. E. G. Kensit, a member of the Botanical Department of the South African College, has been killed in the war.

The *Auk* for October contains obituary notices of several ornithologists, John Alexander Harvie-Brown, D.D., died at his residence, Dunipace House, Stirlingshire, Scotland, July 26, 1916. He was born at Dunipace, August 27, 1844, and spent his life there, being a landed proprietor who devoted himself to natural history. He was best known for his work in connection with the "Vertebrate Fauna of Scotland," of which he was chief editor and author of many of the volumes. He was also the founder, owner and joint editor of the "Annals of Scottish Natural History," as well as a supporter of its successor, "The Scottish Naturalist." Col. Herbert Hastings Harrington, the British ornithologist, noted for his work on the "Birds of Burma" (1909) and for numerous papers on Indian birds, was killed in the campaign in Mesopotamia on March 8, 1916. He was born on January 16, 1868, at Lucknow. Lieutenant-Colonel Boyd Robert Horsbrugh, well known as the author of "The Game Birds and Water-Fowl of South Africa" and of numerous articles in *The Avicultural Magazine* died at his home in Surrey, England, on July 11, having been invalided home from France in 1915. Colonel Horsbrugh was born at Poona on July 27, 1871. John Claire Wood, known in Michigan as an oologist and ornithologist, died June 16, 1916, at his home in Detroit, aged forty-five years.

UNIVERSITY AND EDUCATIONAL NEWS

Pledges have been received for the full amount of the Vassar College million dollar endowment fund. $200,000 had been pledged by the General Education Board of the Rockefeller Foundation on condition that the balance be raised. The fund will be used for the endowment and equipment of the college.

The merger of the medical department of the University of Pennsylvania and the Jefferson Medical College has been postponed for a year, and it is thought that the union may be abandoned.

The new chemistry building of the Throop College of Technology which with its equipment will cost nearly $100,000 is approaching

completion and will be ready for occupancy about December 1, when Dr. Arthur A. Noyes will go to Pasadena, where from now on he will spend half of each year. James H. Ellis, Ph.D. (Mass. Inst.) has been appointed research associate in physical chemistry in the college.

The appointments of Drs. Edward H. Nichols and Charles A. Porter as clinical professors in the Harvard Medical School have been confirmed by the university's board of overseers. Both men formerly held positions as associate professors.

Harold Veatch Bozell has been appointed assistant professor of electrical engineering in the Sheffield Scientific School of Yale University for the college year 1916–17, for which period he has secured leave of absence from the University of Oklahoma, where he is dean of the school of electrical engineering and professor of electrical engineering.

Professor C. N. Haskins, of Dartmouth College, has been promoted to a full professorship of mathematics. Drs. R. D. Beetle and F. M. Morgan have been promoted to assistant professorships of mathematics.

Roy G. Hoskins, associate professor of physiology in the Northwestern University Medical School, has been promoted to be full professor and head of the department. Virgil Ernest Dudman, M.D., interne in Cook County Hospital, Chicago, has been elected assistant professor of hygiene and director of student health.

H. H. Bunzell, Bureau of Plant Industry, has been appointed assistant professor of biochemistry at the University of Cincinnati Medical School.

Dr. A. A. Bennett, of Princeton University, has been appointed adjunct professor of mathematics at the University of Texas.

O. F. Burger has been appointed instructor in plant pathology in the Graduate School of Tropical Agriculture of the University of California at Riverside, and Alfred Free Swain, formerly of Montana State College and of Stanford University, assistant in entomology there.

DISCUSSION AND CORRESPONDENCE

COLLOIDS AND NEGATIVE SURFACE TENSION

In a review of Professor Fischer's translation of Wo. Ostwald's "Handbook of Colloidal Chemistry" which recently appeared in this journal,[1] Professor W. A. Patrick states that the existence of negative surface tension which is assumed by Ostwald is contrary both to experimental evidence and to the fundamental ideas of surface tension. Although the present writer does not agree with all of Ostwald's energetic considerations, he wishes to point out that the existence of negative surface tension under certain circumstances is not only supported by a vast body of experimental evidence but is necessitated by the thermodynamic theory of the stability of colloidal solutions.

Surface tension may be defined in the usual way as the work which has to be done in order to increase the surface in question by one square centimeter, this increase in surface being carried out of course reversibly and isothermally. This work, however, and hence also the surface tension, may be either positive or negative.

If for a given two-phase system the surface tension at the boundary between phases is positive, then a positive quantity of work will have to be done in order to increase this surface, and such an increase in surface will be accompanied by an increase in the free energy of the system. Since all spontaneous changes in a system must be in the direction of decrease of free energy, these systems with positive surface tension if left to themselves will automatically decrease the surface between phases. Thus, for example, in the case of finely divided crystals of copper sulfate in contact with a saturated solution, we have a system in which there is positive surface tension at the boundary between the phases, and if this system is left to itself there will be a spontaneous decrease in surface, the smaller crystals going into solution and precipitating on the larger until finally we have all the solid copper sulfate in one large crystal, this being the condition of smallest possible surface.

If, on the other hand, we have a two-phase

[1] Science, 43, 747, 1916.

system with negative surface tension at the boundary between phases, instead of it requiring work to increase the surface, the system could actually be made to do external work on its surroundings when an increase in surface takes place. In such systems there will obviously be a *decrease* in free energy accompanying increase in surface and if left to themselves these systems will spontaneously increase their surface either by an increase in the convolutions of the boundary or by dispersion into smaller particles. Since spontaneous changes can only take place when accompanied by decrease in free energy it is evident then that *we have negative surface in the case of all systems which are undergoing a spontaneous increase in surface.*

There are of course, as a matter of fact, an enormous number of systems which undergo spontaneous increase in surface, and hence possess negative surface tension. All of the hydrophyllic colloidal substances, such as gelatine, agar-agar, lecithin, etc., will spontaneously disperse when placed in contact with water and hence have negative surface tension. (When lecithin is placed in contact with water the formation of protuberances and consequent increase in surface can be observed under the microscope.) Also in the case of hydrophobic colloidal systems it is well known that under proper conditions an increase in the degree of dispersion will take place; thus colloidal solutions of ferric hydroxide increase their dispersion when hydrogen ion is added to the solution, flocculent gold can be dispersed with ammonia,[2] ferric hydroxide which has been precipitated with sodium chloride is redispersed when the chloride is washed out,[3] and, as shown by Mr. R. J. McKay working in the writer's laboratory, the size of the particles in a colloidal solution of carbon (Higgin's drawing ink) depends on the concentration of added sodium chloride, and particles whose size has been increased by addition of sodium chloride grow gradually smaller again on dialysis with pure water. Hence in all these cases we have experimental evidence of negative surface tension.

From the foregoing considerations we see that there is positive surface tension in the case of all colloidal solutions in which the size of the dispersoid particles is automatically increasing, and negative surface tension in case the size of the particles is decreasing, and that for stable colloidal solutions the surface tension at the boundary between dispersing medium and dispersoid will be zero. Furthermore, since in cases where automatic dispersion is taking place, this continues only until a definite size of particle is reached, we are led to the conclusion that surface tension is in general a function of the size of the particles. A stable colloidal solution is thus one in which the particles have that particular size which has zero surface tension.

Such ideas as to positive, negative and zero surface tension, and as to the relation between surface tension and size have already appeared in the literature. The possibility of explaining automatic colloidal solution and the permanent colloidal state by assuming a negative surface tension between phases which becomes zero at a definite degree of dispersion was first outlined by Donnan,[4] on the basis of a suggestion of Van'T Hoff; has also been expressed by Perrin,[5] and has been definitely adopted by the present writer on thermodynamic grounds in a presentation of a somewhat complete thermodynamic theory of equilibria of dispersed systems in general and of colloids in particular.[6]

[2] Whitney and Blake, *J. Amer. Chem. Soc.*, 26, 1,341, 1904.

[3] Linder and Picton, *J. Chem. Soc.*, 87, 1,924, 1905.

[4] Donnan, *Z. physik. Chem.*, 37, 735, 1901; 46, 197, 1903. It is possible that Donnan has since abandoned this theory as a satisfactory explanation of the colloidal state. See Ellis, *Z. physik. Chem.*, 80, 611, 1912.

[5] Perrin, *J. chim. phys.*, 3, 92, 1904. "Il me semble donc que l'existence même d'un hydrosol force à regarder la tension superficielle comme étant un fonction du diamètre du granule, fonction qui, nulle pour un certain diamètre, est positive pour un diamètre inférieur, et negative pour un diamètre supérieur." In a later paragraph (*loc. cit.*, p. 94) Perrin somewhat modifies this point of view that the surface tension is exactly zero at the degree of dispersion which is stable.

[6] *J. Am. Chem. Soc.*, 35, 317, 1913.

It has there been shown that such ideas can be successfully employed for the general treatment of the phenomena of lyophobic and lyophyllic colloids. In the case of lyophyllic colloids it is pointed out that in general the surface tension for undispersed dispersoid is negative and hence automatic dispersion takes place until the size of particles is reached which have zero surface tension. While for lyophobic colloids large particles have positive surface tension, and this only becomes zero for very small particles. This necessitates a preliminary dispersion by electrical, mechanical or chemical means for the artificial preparation of lyophobic colloidal solutions which unlike lyophyllic colloidal solutions are of infrequent occurrence in nature. The writer has also discussed there the rôle of the electrical charge always present on lyophobic colloidal particles in producing the state of zero surface tension necessary for permanent stability.[7]

Freundlich[8] is perhaps the principal exponent of a theory of colloidal solution which does not take zero surface tension as the necessary accompaniment of the stable colloidal state. According to this theory the surface tension at the boundary of the dispersoid particles is always positive and hence there is always a tendency for the particles to unite with decrease of surface. The electrical charges on the particles, however, by mutual repulsion prevent such a union and keep the system in a permanent, although thermodynamically unstable state. Although the writer would not deny that there may be some colloidal solutions which may be in a relatively permanent state without having really reached a condition of minimum of free energy, he believes, however, that the Freundlich theory is entirely inadequate for a general treatment of colloidal phenomena. Not only does the absolutely permanent stability of colloidal solutions point to true thermodynamic equilibrium, but the actual growth of particles to a new equilibrium size on small additions of electrolytes to colloidal solutions and their redispersion to the old size on washing out the electrolyte could only be the case if we have a real thermodynamic equilibrium. Furthermore, Freundlich's assumption that an actual collision and union of particles is necessary for a decrease in degree of dispersion seems to be entirely unjustified since with positive surface tension, as is well known, the material in the smaller particles would have a higher solubility than that in the larger particles, and the latter would grow at the expense of the former. Indeed, the *continuous* growth of particles from one equilibrium size to another is evidence that some other process than that of simple union is taking place. Finally, the existence of a *definite equilibrium size* of particle contradicts his theory since if the stability were due merely to an electrical repulsion that kept particles apart this would work equally well with particles of all sizes, while microscopic examination shows that in typical lyophobic colloidal solutions all the particles have the same size except for a few very large ones which are floating around with the others and are apparently so large that they lie in the region of positive surface tension which, as we have already seen, characterizes *undispersed* lyophobic dispersoid.[9]

Richard C. Tolman
Laboratory of Physical Chemistry,
University of Illinois

[7] If we wish to extend our considerations to the case of particles so small that they contain only a few ultimate molecules, it may seem somewhat misleading to speak of a definite value of the surface tension, and in that case it may seem more desirable to relate the free energy of the dispersoid directly to the degree of dispersion, without intermediate considerations as to surface tension. This, however, involves no change in principle in our method of attack.

[8] Freundlich, "Kapillarchemie," 1909.

[9] There are of course in all probability some lyophobic dispersoids in which the surface tension is nearly zero for particles having a considerable range of size, and in such cases even in a stable solution there will be considerable variation around the equilibrium size of particle. Indeed, in colloidal solutions in equilibrium, we shall expect in general a distribution in the size of the particles according to the laws of probability around that size which has exactly zero surface tension, and the more rapid the change of surface tension with dimensions the more nearly will all the particles be of the same size.

THE AURORAL DISPLAY OF AUGUST 26

IT may interest the readers of SCIENCE to know that the "remarkable auroral display" described by Professor Nutting in SCIENCE of October 6, was visible also in the eastern states. I watched it for many hours at my cottage on Chebeague Island, Maine; and others, who watched it there, declare that it lasted until well after midnight.

The display was of so unusual a character that I could not believe it to be the "northern lights." As Professor Nutting says, its greatest intensity and brilliancy was in the zenith, and to us the light seemed to radiate and pulsate from *east* to *west*. This fact led me to call the display the zodiacal light, which I had never seen, and about which I knew only the name. I should be glad to know if the phenomenon was, without question, an aurora borealis.

L. M. PASSANO

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

I WAS much interested to read Professor Nutting's description of the remarkable auroral display of August 26. I observed the same phenomenon at Annisquam, Essex County, Mass., which Professor Nutting so well described. Auroras were of quite common occurrence this summer at Annisquam, I having noted them on the evenings of June 22, 29, 30, August 26, 27, 28, and September 2, 9 and 11, but the display of August 26 far surpassed any aurora I had ever seen. The Boston papers of August 27 made a note of the aurora and stated that the telegraph and telephone lines in eastern Massachusetts had been greatly disabled and in some cases put out of commission during the previous evening. It would be interesting to know if wireless telegraph operators noticed any unusual occurrence of "static" at that time.

BARRY MACNUTT

LEHIGH UNIVERSITY

THE remarkable auroral display described by Professor Nutting in a recent number of SCIENCE was also observed on the same date, August 26, at Rochester, N. Y., from the Cobb's Hill reservoir. A member of my family called our attention to what appeared to be vivid flashes of sheet lightning. Close observation, however, showed that the apparent electrical display was really an exhibition of the great northern lights or aurora borealis. As described by Professor Nutting, the lights flickered, streamed in great sheets, danced in long shafts, and shimmered in vast expanses of rapidly changing light.

The light was strongest and most remarkable at the zenith where the play was the most intense. The quickly changing forms of the display followed each other with marvelous rapidity as noted by Professor Nutting. In Rochester the light resembled electricity, the colors of the northern Michigan display being absent or but feebly visible, owing probably to the greater distance south of the observing locality. The display was first seen about eight o'clock in the evening and was under observation until after ten o'clock. How much longer the display lasted I am unable to state. It would be of interest to know in what other places far removed from Michigan this auroral display was observed.

FRANK C. BAKER

THE NEW YORK STATE COLLEGE
OF FORESTRY,
SYRACUSE UNIVERSITY

C. C. NUTTING has accurately described the aurora borealis which spanned the northern heavens up to the zenith on the evening of August 26, 1916, at Lake Douglas in northern Michigan. Identically the same aurora was seen by me on the same evening between the hours of nine and ten, at Oak Bluffs, on the eastern shore of Martha's Vineyard, Mass., but somewhat dimmer, owing perhaps to my station on the seashore. The pulsations of light in the form of huge bands changing constantly in intensity and position, as well as the formation of the streamers which he has described, were marked features of the phenomenon.

JOHN W. HARSHBERGER

UNIVERSITY OF PENNSYLVANIA

IN the current issue of SCIENCE, Professor Nutting describes an aurora seen by him on the evening of August 26, remarkable for the large expanse of the heavens which it occupied. It may be of interest to know that the same display was visible a thousand miles east of

where Professor Nutting saw it. I observed the same thing on that evening at Starr's Point, near Wolfville, Nova Scotia. The same great extent of the display was evident, but the brightness was not equal to that described by Professor Nutting. At intervals the display would vanish, to reappear shortly in as great an extent as before. The focus of the aurora seemed to be near the zenith as Professor Nutting describes it.

The aurora was noticed as soon as it was dark, which in that latitude and at that time was about eight P.M., and lasted for two hours at least; how much longer I am unable to say. The color was uniformly a pearly white; no trace of any other tint appeared.

PAUL R. HEYL

PHILADELPHIA, PA.

THE SCIENTIFIC APPOINTMENTS OF PRESIDENT WILSON

TO THE EDITOR OF SCIENCE: In the published discussions of the wisdom of the president's appointments in the so-called scientific bureaus of the government and especially in those regarding his recent choice of a superintendent for the Coast and Geodetic Survey I have seen no reference to one phase of the subject that seems to me to be, at the present time, of the utmost importance.

Great emphasis is now placed by the president and his cabinet on the necessity for "mobilizing" all of the resources of the country, both material and human, so that these resources shall be instantly and completely available for the defense of the country in case such defense shall be called for and extraordinary measures are being resorted to for that purpose.

Those familiar with the work and history of the service will be inclined to think that in the event of an attack by any great power possessed of a strong navy (we are in little danger from any other) the success of our defense will depend in large measure upon the efficiency of the small corps of men constituting the United States Coast and Geodetic Survey. These men have an intimate knowledge of our coast in all its vast extent, of all the avenues of approach, of obstacles that exist and where such may be easily created, and of the topography of a wide strip of land bordering on the sea, possessed by no other body, and in time of war involving naval attack and attempted landing of troops their knowledge will be invaluable. This fact was fully recognized during the civil war of half a century ago and almost from the beginning the regular operations of the survey were suspended that its officers might be detailed to various military operations on the coast. The superintendent himself personally undertook preparations for the defense of the city of Philadelphia.

Military and naval officers everywhere gave unstinted praise to the work of the officers of the Coast Survey, declaring in many instances that without their cooperation important military operations would have been impossible. Under the conditions of modern warfare, when fighting is directed by maps and charts, the enemy being often so far away as to be quite invisible, it is clear that such services as the Coast Survey can render will be immensely more important than they were during the civil war. Indeed it is no exaggeration to say that this small but unique group of highly trained experts under proper leadership should be worth more than half a dozen super-dreadnaughts. One may be rash to compare their possible usefulness with that of the recently organized and mobilized aggregation of assorted geniuses from which the president and the country at large are expecting so much, but some knowledge of the work of the officers of the survey during the civil war and a study of the newly developed methods of warfare may justify or excuse such rashness. These facts alone, without considering others, some of which were presented by Dr. Evermann in a recent number of SCIENCE, seem sufficient to account for the surprise and disappointment that were almost universal among those having knowledge of the situation when the president selected as the head of this, the oldest and one of the most important of the scientific bureaus of the government, not one of a considerable number of men who by reason of their reputation and accomplishments are

eminently fitted for the important office, but one who, though personally quite irreproachable, was totally ignorant of the operations of the great organization which he was called upon to direct and whose previous training and experience are such as to leave little hope that he will ever be able to acquire more than a very superficial knowledge of these operations.

The incident, with others of a similar character recently brought into public notice, serves to illustrate the folly of making appointments to places in the government demanding special qualifications for either personal or political reasons. Happily the practise is becoming more infrequent as administrations come and go and the more the people realize its costly and disastrous consequences the sooner it will disappear entirely.

R.

THE CARNEGIE FOUNDATION FOR THE ADVANCEMENT OF TEACHING

In view of the critical importance of the issues pending before the Carnegie Foundation for the Advancement of Teaching, it is important that a general expression of views by college and university professors be available. The issues relate to the privileges of retirement and the proposed provisions for insurance and annuities which the foundation has offered in their place. The report of the Committee on Pensions of the American Association of University Professors will soon be available. A group of influential universities have published replies to the proposals of the foundation. The undersigned has published in *School and Society* (October 7, 1916) a general review of the ten years of activity of the foundation with special reference to the pending issues. These several expressions indicate a general and emphatic opposition to the steps proposed by the foundation; they enter into detailed consideration of the grounds upon which such opposition is based. Upon the basis of these documents individual opinions are desired indicating how far and in what respects the contentions are approved. Statements of general approval and disapproval as well as of specific positions approved or disapproved will be helpful in reaching a fair indication of the judgment of those interested. Communications should be made promptly.

Joseph Jastrow

Madison, Wis.

QUOTATIONS

THE BRITISH COMMITTEE FOR SCIENTIFIC AND INDUSTRIAL RESEARCH

The report of the Committee of the Privy Council for Scientific and Industrial Research for the year 1915–16 has recently been issued. The sum at its disposal for the financial year 1915–16 was £25,000, out of which £4,250 was granted to the Royal Society. For the current financial year 1916–17 the vote was £40,000, and at the close of the academic year a sum not exceeding £6,000 will have been granted to a number of individual research workers, students and others. In an appendix is the first annual report of the advisory council. It consists of Sir William S. McCormick (chairman), Lord Rayleigh, Sir George T. Beilby, Mr. W. Duddell, Professor J. A. McClelland, the Hon. Sir Charles A. Parsons, Professor J. F. Thorpe and Mr. Richard Threlfall. There are three standing committees—on engineering, metallurgy, and mining, respectively. A sketch is given of government action in the present century previous to May, 1915, when the presidents of the boards of trade and education received a deputation from the royal and other learned societies, urging the need for government assistance for scientific research for industrial purposes, and the establishment of closer relations between the manufacturers and scientific workers and teachers. The government scheme was issued a couple of months later, and the special committee of the privy council and the advisory council itself were thereupon set up. The object of both committee and council was to be the establishment of "a permanent organization for the promotion of industrial scientific research." Thus was recognized the necessity for organizing the national brain power in the interests of the nation at peace. War has remained as much an art as ever, but its instruments are now not only forged by the man of science, but they need a scientific training for their effect-

ive use. This, the report says, is equally true of the weapons of industry. The brains, even the very processes, that to-day are necessary to the output of munitions were yesterday needed, and will be needed again to-morrow, for the arts of peace. The council was faced from the first with the fact that the war had greatly reduced the number of workers available for research, and it found that certain researches conducted or directed by professional associations in the period preceding the war stood in grave jeopardy of enforced abandonment. The first act of the council, therefore, was to save as many derelict researches as possible; its second was to confer with professional and other societies concerned, especially with chemical and electrical industries; its third to form a register of researches; its fourth to aid research in educational institutions, and its fifth to form the standing committees already mentioned. The appointment of other standing committees is in contemplation. The sphere of universities and technical colleges in relation to the work with which the council is concerned is discussed, and finally certain general conclusions are drawn. The first is that a largely increased supply of competent researches must be found, and the second, that there must be a hearty spirit of cooperation among all concerned, men of science and of business, working men, professional and scientific societies, universities and technical colleges, local authorities, and government departments. It was found that the output of the universities before the war was altogether insufficient to meet even a moderate expansion in the demand for research. It is hinted that hitherto the scientific army in Great Britain has consisted of a brilliant group of staff officers, and it is bluntly said that we have not yet learnt how to make the most of mediocre ability, though without scientific rank and file it will be as impossible to staff the industrial research laboratories that are coming as to fight a European war with seven divisions. The council expects to be able to encourage a longer period of training by the offer of research studentships, but "it is useless to offer scholarships if competent candidates are not forthcoming, and they cannot be forthcoming in sufficient numbers until a larger number of well-educated students enter the universities. That is the problem which the education departments have to solve, and on the solution of which the success of the present movement in our opinion largely depends." The council considers that the organization of research in the interest of various industries must be coordinate. "It must be continuous in its operation, and its ramifications will spread as knowledge grows. It will inevitably tend to bring industries into intimate relation which are at present independent of each other; to transform what have hitherto been crafts into scientific industries; and to require cooperation, not only between different firms in the same industry, but between groups of industries in a continuously widening series of interrelated trades. The forces which are at work in this direction have elsewhere found their expression in connection with the trust and the combine; but we believe, if the real nature of these forces is clearly grasped, that it will be possible to organize them for the benefit, not only of the industries, but of the nation as a whole."—*The British Medical Journal.*

SCIENTIFIC BOOKS

Annals of the Dearborn Observatory, Northwestern University. Volume I., Historical and Descriptive Introduction, Measures of Double Stars. By Philip Fox, director of the observatory. Published at Evanston, Illinois, 1915. 4to. Pp. 229.

Science often moves along paths that soon become obscure to the eye of the historian. He can always trace the course of the highways, marked as they are by published contributions. But he may easily miss the almost equally important though less conspicuous byways through the quiet places—the influence of a great teacher, or the silent force of an example of devotion. He who seeks to account for the great activity in America along the lines of observational astronomy must not overlook or underestimate the part that Burn-

ham has played in this movement. He has planted in two of our great observatories a tradition of faithful observing that will long endure; and from these two institutions the same tradition has been transplanted to smaller and to newer observatories. We are reminded of this by Professor Fox's dedication of this first volume of annals from the Dearborn Observatory: "to Sherburne Wesley Burnham, who spared not himself in his oft heroic vigils, whose personal encouragement has been the direct inspiration for these observations." These words might have been as fittingly written by many another astronomer.

Only a few of the world's great telescopes are used to their full capacity, and most of these few are to be found on this side of the Atlantic. Among them must now be counted the Dearborn telescope, which has been used whenever the sky has permitted on almost every night since the fall of 1909, a date that marks the advent of the present director. This is a remarkable record, for during most of this time Professor Fox has worked single handed, and at no time has he had more than one assistant. Moreover, in addition to his work at the telescope he has fulfilled various administrative duties and has taught classes at the Northwestern University. It is clear that the Dearborn telescope, though it is a beautiful and efficient instrument, is not at present the chief asset of the Dearborn Observatory.

The introduction to this volume contains an historical account of the observatory, beginning with the formation of the Chicago Astronomical Society in 1862, the purchase immediately afterward of the 18½-inch telescope, the early struggle for existence, the almost fatal blow dealt by the great fire of 1871, and finally the happy affiliation in 1887 with the Northwestern University. The telescope was for a time not only the largest in the world but probably also the finest. Its excellent qualities have been proven by the discovery of the companion to Sirius (while still in the hands of its makers, Alvin Clark and Sons); by a long list of measures of difficult objects by Burnham, Hough and Fox; by the excellent photographs that have recently been made with it; and most convincingly of all, by the results of an application to it of the Hartmann tests. Professor Fox carried out these tests in 1912 and 1913 and describes them fully here. They show that when the objective is at its best there is practically no spherical aberration. They also indicate that under certain temperature conditions a considerable amount of aberration may be temporarily present, the effect being similar to the phenomena that the reviewer showed to exist in the case of the Thaw telescope at Allegheny and in one or two other very large refractors. This effect is correlated, not directly with the actual temperature, but rather with the rapidity with which the temperature has changed in the interval immediately preceding the making of the test.

Two chief investigations are now being carried out with this telescope, the determination of stellar parallaxes by photography, and the systematic measurement of double stars. It is to the latter that the present volume is devoted. The random discovery of new double stars or the casual measurement of the best known doubles, does not add much to the progress of this branch of astronomy. Professor Fox has wisely adopted an observing program made up of definite lists of stars that would not be likely to receive attention otherwise. The volume before us is chiefly concerned with the double stars discovered by Holden, with those discovered by Küstner, and with a selected list from Burnham's General Catalog. Much care was expended on the arrangement and printing of the observations, so that the volume is not only a beautiful example of the printer's art, but is one that leaves nothing to be desired on the score of convenience of reference.

Some of the pairs in this volume were measured not only with the Dearborn telescope, but earlier also with one or both of the Yerkes refractors of 12 and 40 inches aperture, respectively. The comparison of the measures of the same object made by the same observer is very instructive. The reviewer has collected all such cases in the volume and has arranged

them in the order of the angular separation of the two components. We thus get the following means, the number in parentheses indicating how many pairs are included in each mean:

MEASURED SEPARATIONS

With the 12-Inch	With the 18½-Inch	
″	″	
0.94	1.14	(5)
1.80	1.96	(5)
2.34	2.43	(5)
3.29	3.32	(5)
4.18	4.25	(5)

With the 12-Inch	With the 40-Inch	
″	″	
0.68	0.85	(5)
1.13	1.34	(6)
1.71	1.87	(4)
2.05	2.22	(6)
2.55	2.57	(5)
3.96	4.03	(8)
4.65	4.66	(6)

With the 18½-Inch	With the 40-Inch	
″	″	
0.83	0.88	(5)
1.54	1.59	(6)
1.98	1.93	(6)
2.45	2.50	(6)
3.54	3.55	(6)
4.34	4.29	(7)

Measures made with the two large telescopes show little or no systematic difference, but those made with the 12-inch yield smaller separations than either of the others, the difference being largest for small separations and becoming negligibly small for separations in the neighborhood of 5″.

In the recently issued Volume 12 of the Publications of the Lick Observatory, Professor Aitken gives a long list of measures of double stars. Many of these were examined with both the 12-inch and the 36-inch telescopes of that observatory, so that we have an opportunity for making the same kind of tests as on Professor Fox's observations. The results similarly collected are as follows:

MEASURED SEPARATIONS

With the 12-Inch	With the 36-Inch	
0.″52	0.″42	(20)
0.62	0.54	(25)
0.71	0.64	(20)
0.81	0.79	(24)
1.07	1.03	(24)
1.38	1.39	(21)
2.13	2.10	(26)
4.49	4.53	(18)

Here again we have a systematic difference that increases as the separation becomes smaller. But in Professor Aitken's measures the difference has the opposite sign from Professor Fox's, the measures with the smaller telescope coming out larger than with the greater telescope. It would be interesting to know whether these are instrumental peculiarities or whether they have their origin in the habits of the observers. In any case it seems likely that a discussion of the systematic errors of telescopes and observers would be well repaid in the additional accuracy with which double-star orbits could be computed after the application of systematic corrections. Some attempts at such a study have been made, but (so far as the reviewer is aware) none of them is as thorough as the importance of this matter warrants. Needless to say that the presence of systematic errors of this kind is evidence for the skill and the care of the observer rather than against. In the work of an inexperienced or careless observer, such small effects as these would be buried under an accumulation of accidental errors.

FRANK SCHLESINGER

ALLEGHENY OBSERVATORY OF THE
UNIVERSITY OF PITTSBURGH,
September 30, 1916

The Sessile Barnacles (Cirripedia) contained in the Collections of the U. S. National Museum; including a Monograph of the American Species. By H. A. PILSBRY. Bulletin 93, U. S. National Museum, 1916.

In this great work, of 366 pages with 76 plates, Dr. Pilsbry brings the American sessile barnacles out of obscurity, and furnishes the means whereby all who will may continue the investigation of the group with as much ease as the nature of the subject permits. A critical review of the book could only be written by one who had covered at least a considerable part of the field by his investigations, and at present Dr. Pilsbry stands alone in this country in his knowledge of barnacles, with no

one competent to criticize his results in any detail. All we can say is that we recognize the same lucidity and fullness of treatment, and the same broadly philosophical point of view, which have long been familiar in the writings of the author on Mollusca. Adding to this the beautiful and abundant illustrations, it seems that there is nothing left to be desired.

To the general zoologist, perhaps the most interesting part will be that in which the work of Darwin on barnacles is reviewed. Darwin wrote about sixty years ago, and to-day Dr. Pilsbry has this to say of his work:

"His grasp of detail was so comprehensive and his language so lucid that one can not expect to improve upon them. In the field he covered one can not do better than to imitate. Yet it has been possible to extend the work in certain directions."

"His monograph on the subclass Cirripedia is one of the most brilliant morphologo-systematic studies to be found in the whole field of systematic zoological literature."

Under *Balanus* (p. 50) we read:

"It is a remarkable testimony to Darwin's insight and restraint that every one of the species of *Balanus* admitted by him is still accepted as valid."

Under Coronulinæ (p. 269):

"We owe to him a discussion of the morphology of the group so lucid that no subsequent student has been able to add anything of importance."

Under Chthamalidæ (p. 292):

"We owe the establishment of this family solely to the taxonomic genius of Darwin, who first brought the genera together and demonstrated their relationship. I have examined and dissected many more species, I suppose, than any one else, and I find all of the evidence supports Darwin's views."

Thus, had Darwin never been known as a great philosophical naturalist and evolutionist, he would still have stood in the front rank as a brilliant taxonomist and morphologist.

One of the important facts brought out by Dr. Pilsbry is that the so-called cosmopolitan barnacles, when belonging to the littoral or shallow-water fauna, present numerous subspecies which conform in general to the faunal provinces already recognized for other marine animals. In general, also, the distribution of species is more restricted than has been supposed, as it is found that many of the records are taken from specimens attached to ships, far out of their natural range.

It appears that the British Museum, which contains Darwin's types and the *Challenger* materials, has the most important collection of barnacles in existence. Second to this is the U. S. National Museum, which possesses no less than 76 types.

T. D. A. Cockerell

University of Colorado,
September 3, 1916

SPECIAL ARTICLES

ANTAGONISTIC SALT ACTION AS A DIFFUSION PHENOMENON

1. The writer pointed out in 1905[1] that the antagonization of the toxic action of NaCl by $CaCl_2$ (or in general of salts with univalent cation by small quantities of a salt with bivalent cation) was due to the Ca preventing the diffusion of the NaCl through the membrane of the cell. It is often difficult to decide whether or not the antagonistic salt action is a diffusion phenomenon or a phenomenon due to the action of the salt upon the living protoplasm. We possess, however, one object in which definite proof can be furnished that the antagonistic salt action is merely a diffusion phenomenon, due to a direct action of one (or both salts) on the membrane and not on the protoplasm; namely, the egg of *Fundulus*. In this case the embryo is the living protoplasm and by comparing the action of salts on the egg, while the embryo is still inside, with the action of the same salts when the embryo is freed from the membrane, we can make sure that the phenomena of antagonization observed in the egg of *Fundulus* are diffusion phenomena. This may be illustrated by a few simple examples.

[1] Loeb, J., *Arch. ges. Physiol.*, 1905, CVII., 252.

In his paper of 1905 the writer pointed out already that $ZnSO_4$ retards the injurious action of a $m/2$ or 5/8 m solution of NaCl upon the embryo inside the egg, while the newly hatched fish dies more rapidly in a $m/2$ or 5/8 m NaCl solution when a trace of $ZnSO_4$ is added; and that this fact was only comprehensible on the assumption that the antagonistic action of the $ZnSO_4$ in the former case was due to an action of this salt upon the membrane, whereby the rate of diffusion of the NaCl through the membrane was diminished.

When we put eggs of *Fundulus* from six to ten days old into a 3 m NaCl solution the embryos are killed and coagulate inside of five hours, for the reason that in this concentration the NaCl is able to diffuse through the membrane, which is practically impermeable to water as well as to balanced salt solutions of not too high a concentration. When we add 1 c.c. 10/8 m $CaCl_2$ to 50 c.c. 3 m NaCl, the embryo will keep alive (as indicated by the continuation of heartbeat, circulation, and spontaneous motions of the whole embryo) for from three to five days.[2] This prolongation of life through the addition of Ca is due not to an action upon the protoplasm but to a prevention of the diffusion of the NaCl into the egg, since if we take the embryo out of the egg (or use the newly hatched embryo) it is killed in 50 c.c. 3 m NaCl + 1 c.c. 10/8 m $CaCl_2$ inside of a few minutes. The antagonistic effect of the $CaCl_2$ consisted therefore in this case in the Ca modifying the egg membrane in such a way as to retard the diffusion of NaCl through the membrane. Since the objection might be raised against this conclusion that a slow diffusion of Ca into the egg counteracted the effects of an almost equally slow diffusion of NaCl upon the fish itself, we may add that the experiment succeeds just as well if the $CaCl_2$ is replaced by $MnCl_2$, which is not able to counteract the injurious action of NaCl upon the embryo outside the egg, while it counteracts the injurious action of NaCl upon the embryo while the latter is inside the egg. The antagonistic action of Ca or Mn or $ZnSO_4$ (or any salt with bivalent cation) upon the injurious action of a NaCl solution consists, therefore, in the case of the egg of *Fundulus*, purely in the prevention or retardation of the diffusion of NaCl through the membrane of the egg.

[2] Loeb, J., *Biochem. Ztschr.*, 1912, XLVII., 127.

KCl is a general nerve and muscle poison and causes cessation of the heartbeat in comparatively low concentrations. When we put the eggs of *Fundulus*, after heartbeat and circulation are established, directly from sea-water into $m/8$ KCl the hearts stop beating in a few hours. If, however, the $m/8$ KCl solution is made up in $m/1$ NaCl + $CaCl_2$ the embryo may live in the solution for ten days or more. That we are dealing in this case of antagonism also with a diffusion phenomenon is made certain by the fact that the combination $NaNO_3$ + $MnCl_2$ is practically as good an antagonist against KCl as is NaCl + $CaCl_2$, as long as the embryo is in the egg; while when it is out of the egg the mixture $NaNO_3$ + $MnCl_2$ (as well as $NaNO_3$ or $MnCl_2$ alone) is unable to antagonize KCl.

These examples, to which many others might be added, show that the phenomena of antagonism described by the writer for the egg of *Fundulus* are purely diffusion phenomena and due to a direct action of the salts on the membrane of the egg and not due to an action of the salts upon the protoplasm of the embryo.

2. The experiments on the egg of *Fundulus* give us therefore an unusual advantage, inasmuch as they allow us to decide with certainty whether the phenomena of antagonism are diffusion phenomena or phenomena due to the action of salts upon the protoplasm; since we can easily separate the protoplasmic part of the egg—the embryo—from the membrane. On account of this unusual advantage the writer has made this object the basis of his work on the theory of physiologically balanced solutions. When we deal with cells whose membranes we can not remove at desire we have a reason to doubt whether or not the phenomena of antagonistic salt action are also of the order of diffusion phenomena. The observations of the writer on the fish itself seem to indicate that phenomena of diffusion enter

here just as well, since there is a far-reaching parallelism between the rules of antagonism for the isolated fish and the egg. Thus Loeb and Wasteneys have shown that the fish *Fundulus* dies more slowly in a pure $m/100$ or $m/50$ KCl solution than when 10 molecules of NaCl are added to 1 molecule of KCl; while the toxic action of KCl is prevented when 17 or more molecules of NaCl are added to 1 molecule of KCl.[3] The writer has recently found that the same fact is true for the eggs of *Fundulus*, with this difference only, that much higher concentrations of KCl are required to demonstrate the phenomenon in the egg than in the fish; and that a much wider range of antagonistic salts can be used in the case of the egg than in that of the fish. This difference, however, can easily be accounted for by the difference between the membrane of the egg and the skin of the fish.

The fact that the stimulating action of salts upon nerve and muscle is inhibited by Ca may also be due to the prevention of the diffusion of the stimulating salts into the nerve or muscle by the Ca.[4]

The writer is in no position to state whether or not Osterhout's[5] interesting observations on the electric conductivity of *Laminaria* may be interpreted as diffusion phenomena, since it is not possible in that object to separate the direct action of the salts on the membrane from that upon the protoplasm. The death of a cell under the influence of a salt must be ascribed to an action of the salt upon the protoplasm, but this action can only take place after the salt has been able to diffuse through the membrane.

The diffusion of certain electrolytes through a membrane seems to depend in addition to the osmotic pressure of the salt in solution upon a second effect which the writer has called the general salt effect.[6] This effect he attributes to a combination of the salt with certain constituents of the membrane, presumably proteins.

3. There are certain kinds of antagonism which seem peculiar to phenomena of irritability and which can not be found in phenomena of diffusion. Thus the larvæ of the barnacle are unable to swim when put into a mixture of $NaCl + KCl + CaCl_2$ until some $MgCl_2$ is added; they are also unable to swim in a mixture of $NaCl + KCl + MgCl_2$ without $CaCl_2$.[7] It is not strictly correct to call this a case of antagonism between Ca and Mg, since in mixtures of $CaCl_2$ and $MgCl_2$ (without $NaCl +$ KCl) the animals are no more able to swim than in a mixture of NaCl and KCl alone or of $NaCl + KCl + MgCl_2$. Either Ca or Mg suffices to counteract the diffusion of $NaCl +$ KCl through the membrane of *Fundulus*, and it is not necessary to add both. The writer had first observed this type of antagonism in the rhythmical contractions of the jellyfish *Polyorchis*[8] and it was afterwards observed by Meltzer and Auer in mammals.[9] It may be peculiar to special sense organs or other animal structures since the writer was not able to observe it in *Euglena*.

JACQUES LOEB

THE ROCKEFELLER INSTITUTE FOR MEDICAL RESEARCH, NEW YORK

[3] Loeb, J., and Wasteneys, H., *Biochem. Ztschr.*, 1911, XXXII., 155.

[4] Loeb, J., and Ewald, W. F., *Jour. Biol. Chem.*, 1916, XXV., 377.

[5] Osterhout, W. J. V., SCIENCE, 1916, XLIV., 395.

[6] Loeb, J., *Proc. Nat. Acad. Sc.*, 1916, II., 511.

[7] Loeb, J., *Jour. Biol. Chem.*, 1915, XXIII, 423.

[8] Loeb, J., *Jour. Biol. Chem.*, 1905–06, I., 427.

[9] Meltzer, S. J., and Auer, J., *Am. Jour. Physiol.*, 1908, XXI., 400.

THE ELECTRICAL CONDUCTIVITY OF SOLUTIONS AT DIFFERENT FREQUENCIES

V.[1] ON THE MEASUREMENT OF THE TRUE AND APPARENT ELECTRICAL CONDUCTIVITIES AND THE INDUCTANCE, CAPACITY, FREQUENCY AND RESISTANCE RELATIONS

FOR the past two years the authors have been engaged in a detailed study of the passage of alternating currents at different frequencies through solutions of electrolytes. For a source of current we have used several generators but especially the Type *B* Vreeland

[1] Summary of a paper given at the Urbana meeting of the American Chemical Society, April 18, 1916.

oscillator sold by the Western Electric Company, as it gives a pure sine wave form and the frequency of the current can be varied at will over a range of 160 to 4,200 cycles. We have also arranged with Vreeland for Leeds and Northrup to sell a smaller instrument giving 500, 750, 1,000 and 1,500 cycles per second.

Curtis coils were used in our bridge, as by this means we could practically eliminate inductance and capacity effects which are a source of error when inductive resistances are used. Tuned telephones sold by the Western Electric Company were used so that the minimum could be detected as accurately as possible.

Several different bridge arrangements have been used for measuring the capacities, inductances and resistances. In order to measure a "cell constant" it is necessary to determine both the resistance and the capacity given by the standard solution of ($N/10$, $N/50$, $N/1{,}000$) potassium chloride at different frequencies. A substitution method suggested by Curtis for measuring resistances was used, as it prevents errors due to any changes in the resistances of the bridge coils, or of the inductance, caused by variations in temperature, and allows the experimenter to read the resistances directly instead of having to make involved calculations.

Resistance measurements made on a given solution in a given cell by using (1) an inductance in series with the cell and (2) a condenser in parallel with the resistance arm checked to within 0.001 per cent. when all necessary corrections are made.

We have used a new type of cell in which each electrode is supported in four places, so that it can not move and thus change the cell constant. We have also made all joints to come below the surface of the water so that there can be no error from evaporation of the solvent. One criterion of good cells is that *whatever the solutions used the ratios of the resistance of any solution in two such cells, or of two solutions in any cell, must be constant to within 0.01 per cent. at infinite frequency.*

It was found that resistance readings on a given cell with a given solution can be repeated easily with an average deviation within ± 0.001 per cent.

Even in the old type cells, and when no special precautions were taken in transferring the solutions, resistance measurements on different parts of the same solution in the same cell checked to within 0.01 per cent.

When solutions of electrolytes were allowed to stand in cells for 24 hours, the resistance of the solution in the cells with platinized electrodes did not change, while in those with bright electrodes the resistance increased at the rate of about 0.003 ohm per hour.

There is no measurable change in the resistance of a solution, or the capacity of the cell, with change in voltage from 0.25 to 8 volts, provided the cells, solutions and containers are kept scrupulously clean, and the polarization voltage is kept below 1.23 volts. Dr. G. H. Gray is studying this problem by the use of the oscillograph.

The capacities in cells with bright electrodes vary from 10 to 1,000 microfarads, while in cells with platinized electrodes they range from 500 to 5,000 microfarads.

There is no measurable change in the resistance of a solution with change in frequency from 600 to 2,000 in our cells with *platinized electrodes* 1 inch in diameter, and such cells therefore give approximately the true electrical resistance of solutions at any such frequency. The ratios of the resistances of $N/5$, $N/10$ and $N/20$ NaCl measured in two different cells with platinized electrodes show a deviation of not over 0.01 per cent. at these frequencies, which is hardly more than the experimental error.

In cells with *bright platinum electrodes* there is a change in resistance with change in frequency from 250 to 3,000 cycles and higher, and this change depends upon several factors: (1) As the concentration of any given solution is decreased, and therefore the resistance increased, the change in resistance with change in frequency is decreased; (2) as the area of the electrode surface is increased the change in resistance with change in frequency is decreased; (3) as the area of the electrode surface is increased the inductance necessary to

obtain a balance is decreased, and hence the apparent "capacity" of the cell is increased; (4) the higher the apparent "capacity" of the cell, the smaller the change of resistance with change in frequency; (5) solutions of different salts having about the same resistance in the same cell give approximately the same change in resistance with change in frequency from 600 to 1,000 cycles.

By comparing the resistances of $N/10$ and $N/20$ NaCl in two cells, one of which had bright and the other platinized electrodes 1 inch in diameter, it was seen that the ratio for the cell with bright electrodes was much lower than that for the cell with platinized electrodes, but as the frequency was increased the ratio for the cell with bright electrodes approaches that for the cell with platinized electrodes. Extrapolating the resistance for the cell with bright electrodes to infinite frequency, the ratio was found to differ by only 0.01 per cent. from that given by the platinized electrodes. It is thus shown that the true electrical resistance of solutions can be measured or calculated in cells with bright platinum electrodes only at infinite frequency.

Saturation of bright and platinized electrodes with hydrogen produces no appreciable change in the "capacity" of the cell at 60 cycles. This and much other evidence seems to show that the "capacity" does not arise from a neutral gas layer deposited on the electrodes and acting as an air condenser. It is probably due to a "double layer" of the electrolyte and the "contact potential" arising from changes of concentration resulting from electrolysis and to the reverse electromotive force coming from the deposition of ions on the electrodes.

The inductance necessary to balance the "capacity" of the cell is nearly but not quite inversely proportional to the square of the frequency. As this relation holds true for a "leaky" condenser the cell seems to act as a simple condenser with a "leak."

As the frequency of the alternating current is increased the change in resistance of a given solution in a given cell, and also the inductance necessary to balance the capacity of the cell, are decreased, and both approach zero at infinite frequency. The ratio of the difference in the inductance in millihenries to the difference in the resistance in ohms between 600 and 1,000 cycles has a constant value of about 2.00.

Mr. Henry P. Hastings is continuing the work by making measurements of resistance, capacity and inductance at much wider range of frequency, namely, 60, 250, 500, 750, 1,000, 1,500, 2,000 and 3,000 cycles. He has confirmed the fact that a change in frequency produces a change in inductance necessary to balance the cell capacity which corresponds fairly closely to the equation $KL = 1/C\pi^2$. At lower frequencies he observes easily a third harmonic produced by the cell. Mr. Hastings has also confirmed our work by extrapolating the resistances of solutions in cells with bright electrodes to infinite frequency and showing that they approach the values given by the same solutions in cells with platinized electrodes.

He has also found that the ratio of the *change of resistance* which is sometimes 5 per cent. of the resistance, to the *change of inductance* produced when the frequency is changed is approximately constant.

W. A. Taylor,
S. F. Acree
University of Wisconsin

ON THE REGULARITY OF BLOOMING IN THE COTTON PLANT

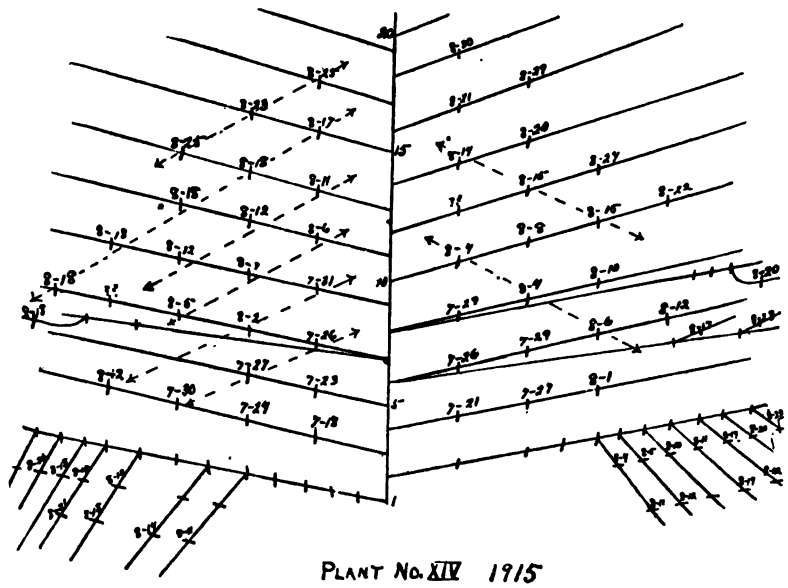
In 1915 the writer carried on some experiments on the water requirement of cotton, in connection with which the blooming records of a number of plants were kept. In looking over these records, there appears to be a sort of regularity in which the blooms opened and two of these records which showed the greater regularity are herein given.

To those unacquainted with the habit of growth of the cotton plant it will be well to first call attention to the different kinds of branches as shown on the accompanying diagrams. On the one of plant No. XIV., those branches numbered one and two are known as vegetative branches; these occur on all plants of this species so spaced as to have freedom in

growth but are often aborted when the plants are crowded, much as are the lower branches of trees in a crowded forest. From each node of these branches secondary fruiting ones grow in a similar manner as do the primary fruiting branches from the main stalk, although the inner ones may be thrown off on account of the dense shade, as will be noted from the diagram.

strength of the plant will be thrown into the fruiting ones and a greater and earlier crop will result.

Out from nodes number six, seven and eight, will be noticed some secondary vegetative branches; from these also fruiting branches occur as from the primary. On small plants, dwarfed from lack of water or of plant food, these are usually wanting but may occur on



Plant No. XIV 1915

Fig. 1. Plant No. XIV.

Above the vegetative branches, coming out from nodes three to eighteen are the primary fruiting branches. The bolls on these are larger and earlier than those found on the secondary fruiting branches mentioned above as well as on those yet to be mentioned; from the complete record of this plant it was noted that seventeen bolls opened on the primary branches before any opened on the secondary. Farmer's Bulletin No. 601 explains a new system of cotton culture which is based on this fact and on that of the abortion of the vegetative branches, mentioned in the preceding paragraph. The claim is made that with thicker planting, late thinning, and by leaving more plants per acre than is usually done, the vegetative branches will be aborted, the

plants having good conditions of environment or may come out as a result of topping or other injury to the plant. The diagram shows no true branching of either vegetative or fruiting branches. Mr. O. F. Cook in Bul. No. 198 of B. P. I. says:

> Pruning or other injury, or renewed growth in late season may cause the formation of secondary limbs from primary limbs, or even from axillary buds of fruiting branches.

He further points out that vegetative branches ordinarily arise from axillary buds and fruiting branches from extra-axillary ones. For other variations in the branching or in the location of the flower bud, the reader is referred to this publication. In these dia-

grams, the branches are shown necessarily as alternate, although occurring on the plant in a spiral.

On the main fruiting branches, there appears normally a single bloom at each node. In the diagram of plant No. XIV., it is shown that the blooming began on the third branch (first fruiting branch) on July 18 and ended on the eighteenth branch on August 30. The intervals between the blooming of the first nodes on consecutive branches varied somewhat, but averaged about three days. The time between blooms on any given branch was approximately double the time between the "vertical" blooms, as given in the preceding sentence. This

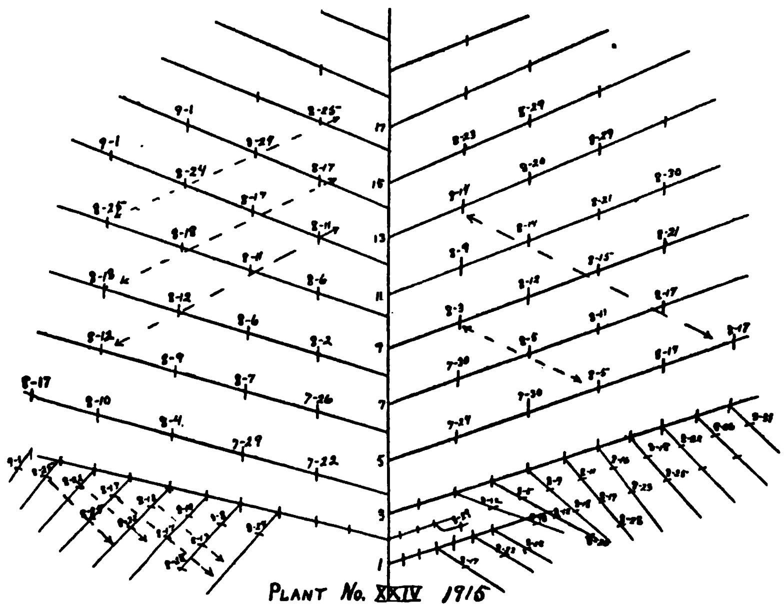


FIG. 2. PLANT No. XXIV.

relation was carried out with the other blooms on any given branch. To put it in other words, *there is an apparent relation,* indicated by the broken arrows on the diagrams, *between the blooms on any one branch and those on the second higher one, in that any given bloom has a tendency to appear at the same time as the one on the second higher branch, one node nearer to the main stalk.*

This regularity occurred on plants of the Cleveland Big Boll variety, grown in potometers. Plant No. XIV. was grown in soil the water-saturation of which was maintained at 90 per cent. Plant No. XXIV. was grown in soil the saturation of which was maintained at 60 per cent. and shows even more than the other this regularity in blooming.

Conditions of environment, such as the water content of the soil, the amount of available plant food, the day and night temperatures, sunniness or cloudiness, theoretically would influence the length of time which exists between blooms and variations in these should cause variations in blooming in plants subjected to the varying conditions; there exists also, no doubt, a difference in different varieties as to the rapidity with which they bloom, but granting this, it is likely that the relation which is pointed out would even then very likely hold true.

As stated, these diagrams are of the two plants which show the regularity to the greatest degree. They show also many instances in which the bloom appeared not on the same day, but one day later than on the second branch above and one node nearer to the main stalk. Then there are many examples showing great irregularity. It would seem that this points to a very interesting field of study on

what is the *order of blooming* in the cotton plant, the normal *time between blooms* both vertically and horizontally, the *inherent tendencies* toward regularity or irregularity of different varieties, and the factors which influence or determine these things.

C. K. McClelland
Georgia Experiment Station

THE SAN DIEGO MEETING OF THE PACIFIC DIVISION OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

The first annual meeting of the Pacific Division of the American Association for the Advancement of Science was held in San Diego, California, between the dates, August 9 and 12. The headquarters for the meeting were maintained in the U. S. Grant Hotel, and the three evening sessions of the meeting were held in the assembly room of the hotel. For the day sessions of societies participating in the occasion convenient meeting places were provided in the San Diego High School by courtesy of the Board of Education of San Diego.

The first of the general sessions of the San Diego meeting was held on Wednesday evening, August 9, Dr. W. W. Campbell, president of the Pacific Division, presiding. Hon. Lyman Gage, of San Diego, spoke in welcome on behalf of the citizens of San Diego, and Dr. D. T. MacDougal, chairman of the executive committee of the Pacific Division, responded on behalf of the Division. These addresses were followed by the address of the president of the Division, Dr. W. W. Campbell, director of the Lick Observatory, Mount Hamilton, upon the subject, "What We Know about Comets," illustrated by stereopticon. After this session a reception, given under the auspices of the honorary reception committee for the San Diego meeting, was tendered to the visiting members of the American Association and of other societies participating in the meeting.

The second general session of the Division was held on Thursday evening, August 10, Dr. D. T. MacDougal, chairman of the executive committee of the Pacific Division, presiding. At this session the executive committee of the Division was reelected to serve for the ensuing year, upon nomination by a duly appointed nominating committee. The members reelected at this time were:

E. C. Franklin, professor of chemistry, Stanford University.

T. C. Frye, professor of botany, University of Washington.

C. E. Grunsky, consulting engineer, San Francisco.

G. E. Hale, director of the Mount Wilson Solar Observatory, Carnegie Institution of Washington, Pasadena.

V. L. Kellogg, professor of entomology, Stanford University.

A. C. Lawson, professor of mineralogy and geology, University of California.

E. P. Lewis, professor of physics, University of California.

These seven elected members, together with the president and the vice-president of the Division, elected by the committee, constitute the executive committee of the Division.

Following the transaction of this business, an address was given upon the subject, "Modern Natural History Museums, and their Relation to Public Education," by Dr. Barton W. Evermann, director of the museum of the California Academy of Sciences, San Francisco. This address was illustrated with stereopticon views of animal habitat groups which are being installed in the museum of the California Academy of Sciences.

The third general session of the Division was held on Friday evening, August 11, Dr. W. W. Campbell, president of the Pacific Division, presiding. At this session the following resolutions, presented by the Western Society of Naturalists, were unanimously endorsed:

In view of the fact that the great natural resources of the sea in this part of the world, long known to naturalists, are beginning to be utilized; and

In view of the fact that these developing industries, notably those of tuna fishing and kelp harvesting, are making conspicuous many problems of great interest, both industrial and scientific, the solution of which is possible only by long and somewhat expensive investigation;

Resolved, that the Western Society of Naturalists urges upon the attention of the government of the United States and the state of California the importance of giving such support, financial, legislative, administrative and otherwise, as may be necessary to place the various sea industries on a thoroughly scientific foundation; and

Resolved, that a committee of five, four from this society and one from the industries be appointed to act in cooperation with other representatives of the industries for the furthering of the ends indicated in these resolutions.

Resolved, that these resolutions be presented to the Pacific Division for its consideration with the hope that its approval may be given.

Following the business of this session an address was presented upon the subject, "The Physician of To-morrow," by Dr. F. F. Wesbrook,

president of the University of British Columbia, Vancouver.

The societies holding meetings on this occasion were the Astronomical Society of the Pacific, the Cordilleran Section of the Geological Society of America, the Western Society of Naturalists, the Pacific Slope Branch, American Association of Economic Entomologists, and the Ecological Society of America. The San Diego Society of Natural History and the Pacific Coast Branch of the American Phytopathological Society also participated in the meetings of the Western Society of Naturalists.

On Friday afternoon, the Women's Board of the Panama-California International Exposition received visiting members of the American Association and of participating societies in the rooms of the board in the California building on the exposition grounds.

The period of the meeting was closed, except for excursions, by a dinner held on the evening of Saturday, August 12, in the U. S. Grant Hotel. At this dinner, Mr. Edward L. Hardy, president of the California State Normal School at San Diego, presided, and addresses were presented by Dr. W. W. Campbell, director of Lick Observatory, Mount Hamilton, California; Dr. John C. Merriam, professor of paleontology and historical geology, University of California; Dr. F. F. Wesbrook, president of the University of British Columbia, Vancouver; and Dr. F. R. Burnham, San Diego.

During the days following the meeting, excursions were arranged as follows:

Through the courtesy of the United States Bureau of Fisheries, the *U. S. S. Albatross* was in port at San Diego during the period of this meeting, and was made available for a demonstration trip on the morning of Saturday, August 12.

Automobiles were provided, through the courtesy of the San Diego Chamber of Commerce, for an excursion to the works of the Western Salt Company, South San Diego, and to the Otay Valley and the Coronado peninsula, on Saturday morning, August 12.

An excursion was arranged on the afternoon of Saturday, August 12, under the auspices of the Ecological Society of America, including in its itinerary the Scripps Institution for Biological Research near La Jolla, an isolated colony of Torrey pines, six miles north of La Jolla, and the beach near the Scripps Institution.

On Sunday, August 13, through the courtesy of the Hercules Powder Company and of Swift and Company, opportunity was afforded members of the association and participating societies to inspect the processes of the chemical reduction of kelp at the plants recently established in San Diego by these two concerns.

A notable excursion occupied Sunday and Monday, August 13 and 14, in which, as guests of the San Diego Society of Natural History, a party of thirty-two was conducted by automobile through the mountains of the central part of San Diego County to the edge of the Colorado Desert, accomplishing a trip of over two hundred miles. Saturday night was spent in camp in the mountains at the edge of the desert.

In the provision for these excursions, the Pacific Division of the American Association is greatly indebted to Mr. E. W. Scripps, of Delmar, San Diego County, for donating a fund from which a great portion of the expense of these excursions was defrayed. The fund placed these excursions within the reach of a large number of visiting members.

On Wednesday afternoon, August 9, the dedication of the recently completed museum and library building and the concrete wharf was held at the Scripps Institution for Biological Research at La Jolla. At these exercises Dr. Benjamin Ide Wheeler, president of the University of California, presided. The invocation was given by the Rt. Rev. Joseph H. Johnson, bishop of Los Angeles, and the following addresses were presented:

The Training of Scientific Men, David Starr Jordan, chancellor emeritus of Stanford University, California.

Biological Research Institutions: Organization, Men and Methods, D. T. MacDougal, director of the department of botanical research, Carnegie Institution of Washington, Tucson.

The Sources of the Nervous System, G. H. Parker, professor of zoology, Harvard University.

What the Scripps Institution is Trying to Do, William E. Ritter, scientific director, Scripps Institution for Biological Research, La Jolla.

The total registered attendance at the San Diego meeting included ninety members of the association and of participating societies from outside San Diego, and thirty members from San Diego and vicinity; making a total of one hundred and twenty. The total number of sessions was sixteen. In addition to the registered attendance, several of the sessions received a large general attendance from San Diego.

Albert L. Barrows,
Secretary, Pacific Division

SCIENCE

FRIDAY, OCTOBER 27, 1916

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MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

"THE PHYSICIAN OF TO-MORROW"[1]

MEDICINE now justly claims an important place with the other sciences. Phenomenal advance in the physical and biological sciences has revolutionized it and given it a definiteness hitherto lacking. In fact, it may be said that medicine has been born, or at least reborn, in the last quarter century. As a consequence, the new science is not yet oriented to those other forces in human environment and relationship which activate social and economic development.

Further, too, it is impossible to foretell with certainty the place of the medicine of to-morrow. Yet institutions charged with the responsibility of preparing medical practitioners, teachers and administrators for their duties in public medicine and in practise, fail in their obligations even when they furnish their graduates with all the necessary tools, if they neglect to provide proper perspective and to develop adequate capacity for the discriminating test of new methods and the proof of new truths which they will be called upon to adapt to their life work as it unfolds. Above all, these physicians of to-morrow must know humanity as well as human anatomy and physiology. They must be trained in the pathology of social conditions as well as in disease processes. They must be as expert in human relationships as in the habits of man's microscopic foes.

Whilst we recognize our limitations as prophets in forecasting the exact status of public and private medicine a generation

[1] Address delivered by F. F. Wesbrook, M.A., M.D., C.M., LL.D., before the Pacific Division, American Association for the Advancement of Science, San Diego, Calif., August 11, 1916.

in advance, we can feel confident that the evolution will be gradual and logical. The task of preparing our successors is difficult but not hopeless. We have opportunity to observe the trend of our own times and should seek to avoid for the next generation those faults and deficiencies so apparent in our own preparation.

It would seem that the first duty of every national government in respect to medical education and licensure is the collection and publication of accurate comparative statistics of the staffs, facilities, equipments and graduates of all its own institutions as a basis for comparison with each other and with those of other countries.

In the absence of such official information, the Carnegie Foundation for the Advancement of Teaching, a private and unofficial organization, in order to meet its own needs, undertook an international study of these matters and published a report on Medical Education in the United States and Canada in 1910 and a report on Medical Education in Europe in 1912. These reports furnish the first accurate information which permits comparison of the medical institutions in America with each other and with those of Europe.

So far as the United States is concerned, this involuntary and quite unofficial stocktaking has inspired official correction of conditions which it was first necessary for the public to know in order to cure under this democratic system of government.

Fortunately, these reports which were begun in the United States and Canada, have brought together the very material needed by all countries in planning for the future and we may be encouraged by the words of Mr. Flexner with which he begins his first chapter of the Report on Medical Education in Europe, when he says:

> Medical education has only of late deliberately set out to overtake medical practise.

If as a result of his thoroughgoing studies he is able to give us this assurance, we can be satisfied that we are already well on the way.

It is only a few years since the profession of medicine prided itself on the thoroughness with which it had reduced "minding its own business" to a science and the cultivation of aloofness to a fine art. Medicine was "holy ground." We have progressed so far, however, that we are now quite ready to agree with Dr. Pritchett's remarks on the occasion of the dedication of the hospital of the State University of Indiana,[2] June, 1914, when he advanced three main reasons why medical education is a matter upon which the layman has a right to be heard.

Firstly, he holds that medical education is primarily a matter of education and not a matter of medicine, in that it involves premedical as well as medical and graduate instruction and in fact the whole national training system.

Secondly, he cites the layman's own interest, since it is he who is made or marred by the medical profession and he therefore naturally wants to know how the members of the profession are trained. He furthermore has a right to public reports upon the ideals, standards, equipment, teachers and graduates of the various teaching institutions in order to exercise discrimination in the selection of his own physician.

Thirdly, he maintains that the layman is interested in medical education on account of his responsibility in matters of public administration. These involve not only public health work, with the control, suppression and eradication of disease, but the formulation and administration of laws relating to standards of medical education, graduation and licensure.

The protection of the general public as

[2] *Journal of the American Medical Association*, August 22, 1914, p. 648.

well as of physicians against overcrowding in the profession is urged on grounds of economy and efficiency by disinterested experts of education, sociology and public affairs, themselves not members of the medical profession.

Time will not permit us more than a glance at the state of affairs which is set forth in accurate detail in the reports mentioned.

The educational systems, primary, secondary, university and professional of Germany, Austria, France, England, Scotland, the United States and Canada have been carefully studied by Mr. Flexner. Attempt was made by him to measure all countries by the same standards and to analyze the conditions found.

Since the outbreak of this world war it is impossible to get accurate statistics, nor if available would it be possible under present abnormal conditions to judge from them as to the efficiency of the existing training mechanisms nor of the probable adequacy or otherwise of the available supply of physicians throughout the world to meet the demand as it was before the war, or as it will be at the conclusion of the war.

All of our standards have disappeared. Old things have passed away.

It seemed sufficient, therefore, for purposes of this discussion, to take those statistics which were available before the war, realizing, however, that *post bellum* evolution will probably be more accelerated than in *ante bellum* times. The following figures were taken largely from Flexner's reports and from the publications of the American Medical Association's Council on Medical Education.

GERMANY

Germany has only the one agency for the training of physicians, her state universities. Twenty-one universities have been in operation for almost a century. Her training system for all her citizens is continuous. There are no gaps and the state provides that training for each which appears most needed for each.

In an exhaustive article on "Continuation Schools in England and Germany," which appeared in the *Fortnightly Review* of February, 1914, Mr. J. Saxon Mills, a well-known British writer, calls attention to the superiority of the German system over the British system. He asks the pertinent question, "Wherein lies Britain's advantage in maintaining a two-ship power while she permits Germany to maintain a two-school power?" Her complete articulation of teaching and investigation with economic and military development has made her the power she is.

The German child goes to school from the time he is six until he is ten. He then enters the gymnasium, where he remains until he is eighteen. The gymnasium combines our school and university work and gives the old-time classical and humanistic training. Of recent years, the realschule and the realgymnasia have been established, in which the basic sciences are given and the classical and humanistic training correspondingly reduced. An increasing number of prospective medical and technical students are now choosing these latter courses instead of the gymnasium. Roughly speaking, graduation from the gymnasium, realschule or realgymnasium is about equivalent to the completion of our second year in a good American university.

Graduates of these three intermediate institutions are now ready to enter the five-year course in medicine afforded by the universities.

Flexner, who is himself an educationist trained in the humanistic school, realizes the rapid increase in the sum total of essential human knowledge and the consequent need for prolongation of the training

period. He discusses at considerable length the importance of early scientific training at the expense of the classics, and refers to several recent important conferences held in Germany in regard to the matter of a premedical education more scientific and less humanistic.

Five years of medicine and a sixth or hospital year permits the student to graduate at the average age of twenty-four years in Germany and his license is issued after a special examination.

All of the various teaching institutions are governmental and related. Graduation from the gymnasium, the realschule or the realgymnasium, where the examinations are conducted by the officers of those institutions, entitles the student to entrance into the university. Students are permitted to register in the university for classes which they may attend or not. When they have been registered in a particular subject for the requisite length of time, they may appear before the professor for examination. If successful, they are given credit for the subject, which is good at any one of the twenty-one universities.

A seeming weakness in the system is the lack of attention paid to sequence of subjects. A source of real strength, when properly controlled, is the migration of students from institution to institution whereby particular attractions in teachers, equipment, clinical or other opportunities are available to a student with some definite object in mind. The special attention paid to research work has enabled Germany to add her share to the world's medical and scientific knowledge, and in fact, had constituted her the Mecca for graduate work in medicine for the rest of the world. However, certain dangers arise from the undue stressing of research work, in that the undergraduate may come to be regarded by the professor as a necessary evil and only useful when he aids in the researches of the staff. This may be at the expense of his general medical training; in fact, the best medical schools of the United States and Canada were undoubtedly not surpassed in their undergraduate work by the German institutions.

Germany's special excellence was the uniformity of her training and the bringing of the whole profession up to a minimum level, which was for some time above that of any other country.

Some few figures in regard to Germany's supply of available physicians may be of interest. In 1885 Germany's population was 45,458,000. She had at that time 15,674 licensed physicians, or a ratio of 1 to 3,000. Her ratio before the war was about 1 to 1,912, varying from 1 to 637 in Munich to a ratio of 1 to 7,718 in Ortelsburg and other thinly populated districts.

Germany's work in the universities seemed entirely adequate to produce thoroughly equipped physicians of fairly uniform training faster than her population increases. The problem of adding new universities is one which is approached in Germany with great deliberation and careful study of population needs and of the universities already existent.

The facilities of German universities for medical teaching and research are familiar to most of us. Undue optimism, particularly in the United States, in regard to opportunities for medical study in Germany and Austria, had arisen on account of the special opportunities afforded visiting physicians. In many instances, instruction was given in English. Abundant material and opportunity were placed at the disposal of the visitor for a monetary consideration which seemed slight to the man in a hurry. On his return when he cited the opportunities which he had been given as showing the superiority of the German or Austrian medical school it usually suf-

ficed to restore his perspective when he was asked whether the German undergraduate students had shared the same opportunities or not. At once he readjusted his ideas when he realized that these graduate courses were often given at the expense of undergraduate training.

AUSTRIA

In Austria the state dominated in education as in Germany, although the mechanism was not so well developed. Conditions were complicated by the bi-lingual situation which demanded at times duplication of effort and expense without commensurate gain in efficiency.

The output of medical practitioners came from the five medical faculties of those universities where instruction is conducted in German. These did not seem to be sufficient for the work. Vienna particularly was overcrowded and the average enrollment in each of the five medical faculties was 736. Austria's population of 28,000,000 demanded the service of 13,202 physicians, a general ratio of 1 to 2,120. Since 1905 the population had increased about 4 per cent. and the practitioners about 6 per cent. Olmütz had a ratio of 1 to 390, whilst the other extreme was 1 to 5,081 in Carniola.

FRANCE

In France the universities under state administration set the standard of medical education and graduation, although medical schools of three different types were found. There were firstly, the eight university faculties, secondly, the schools "de plein exercise" attached to the hospitals in three cities which lack universities, and thirdly, preparatory schools attached to hospitals in 12 non-university towns. These schools offered courses to cover the first two years of the curriculum. In all three, as in Germany, the government appointed the professors, but from the German point of view, not even the French university faculties were built quite on university lines. The two types of accessory schools mentioned were isolated and lacked support, the state financing the universities and the municipality financing the schools.

The total enrollment of 8,850 medical students in January, 1911, consisted of 7,652 students in university faculties, 557 in schools "de plein exercise" and 570 in the preparatory schools. Paris alone had a registration of 4,101. The French student, like his German brother, was systematically trained, with his object clearly before him, so that his education was systematic and continuous. The medical student must have become a baccalaureat, which is the termination of the Lysée, an intermediate or secondary school comparable to the German gymnasium. He was then compelled to pass a year in the university science faculty in the study of preliminary sciences, which in Germany, Great Britain and Canada are illogically included as a part of the medical curriculum. The baccalaureate course and the certificate covering the study of physics, chemistry and biology issued by the university faculty of science, afforded the credential basis of the medical student in France. The average age of graduation in that country was twenty-three years, inclusive of hospital training.

France seemed to be in advance of other countries in insisting that the basis of medical education should be high and uniform and in addition that it be supplemented by thorough courses in those subjects required in the study of modern medicine.

Between 1881 and 1909 an increase of 30 per cent. occurred in the number of physicians, whilst the population of France increased only 10 per cent. Paris had one physician to 1,126 inhabitants in 1894 and 1 to 767 in 1908. The general statement

may be made that the profession in France, as in all other countries, was overcrowded in the city and undersupplied in the thinly peopled districts, because they failed to offer the inducement of a livelihood. Outside Paris the ratio was 1 to 2,360; in Lozerre it was 1 to 3,221.

ENGLAND AND SCOTLAND

In England premedical and medical education are very different from the German system. The following paragraph from the Carnegie report is of interest:

> In striking contrast with organized and systematized Germany are the conditions surrounding secondary education in England.

Mr. Flexner apparently had not the time at his disposal to enable him to become so thoroughly familiar with the complicated English individualistic plan as with the German systematic scheme, with its central and, from the administrative viewpoint, simpler control. He does not discuss the Scotch system of education, which for the average boy has long been much more easily accessible and systematic than in England. One who knows something of the British system can easily sympathize with the dilemma in which Mr. Flexner, an outsider, found himself. Perhaps one of the most striking examples of complexity is afforded by the relations and inter-relations of the various constituent colleges and departments of Cambridge or Oxford, where traditions, centuries old, often constitute the basis of procedure, private and public. Flexner mentions one instance to show the lack of uniformity of standards when he directs attention to a school whose sixth form admits to Oxford whilst it announces publicly that its fifth form prepares for Birmingham or Durham Universities. He could not understand how universities, even those situated in large cities, compete with secondary schools by conducting elementary classes for matriculation.

England and Scotland have twenty-seven medical schools, which is 29 per cent. more than in Germany, although the population is 40 per cent. less than that of Germany.

Considerable space in the report is devoted to the differences in British standards of admission, graduation and licensure, and the adequacy in general of the British examinations is commended. Mr. Flexner says: "Examination is a national industry; getting examined a national habit." I myself think the British examination is probably the main corrective against the lack of uniformity in standards and methods of premedical and medical teaching. The examination system brings many weaknesses and hardships. The English teacher, through fear of written external examination dare not train his boys, in the words of Sir William Ramsay, "to do something instead of know something."

The variation in the requirements for entrance into medicine in Great Britain is tremendous. The student may begin the study of medicine as a graduate in arts or science, or with mere university matriculation, or even on a level distinctly below that which would be demanded by a university for admission. And yet students from these differing educational levels are to be found side by side in all the London medical schools.

It is unnecessary to go into the details of organization and operation of the various medical teaching mechanisms of the universities, colleges, halls and other such institutions, or into the methods of examination employed by various universities, colleges and other bodies, many of which have not taught the students they examine.

Doubtless it seemed strange to Mr. Flexner to find graduates in arts of the Universities of Cambridge and Oxford, most of whom take their clinical work in the London hospital medical schools, re-

ceiving the same clinical instruction and working with the same ends in view, side by side with students whose premedical equipment, according to his opinion, would not have been too much to expect of an average fifteen-year-old boy. It has seemed strange to all of us, I am sure, why if in the opinion of the British authorities twenty-five years ago, it required a five-year training in medicine to prepare the students for the responsibilities of practise, it should not now require considerably longer time, on account of the tremendous increase in our knowledge of the basic and medical sciences and the clinical branches.

In 1891, there were 29,555 registered physicians in Great Britain, whose population at that time was 38,105,975, or a ratio of 1 to 1,289. In 1907 the ratio had become 1 to 1,107. Edinburgh showed a ratio of 1 to 489; the Yorkshire ratio was 1 to 2,057, if we omit thirty-nine towns of a population of 10,000 or upwards. Of recent years the average annual registration of licensed practitioners showed a decline in an attempt to adjust supply to demand. Had the medical profession realized earlier that medicine was not a thing apart, but only one of society's implements for its own betterment, on its own initiative it would have prepared in advance a scheme for its social and economic adjustment and the revolution of medicine precipitated some time ago by Lloyd George would have come as an evolution under the direction of medical statesmen.

In summary, Flexner discusses professional overcrowding in Europe in the following words:

> The foregoing discussion appears to warrant the following conclusions: overcrowding of the profession takes place in Germany and Austria on a high, university basis, in England and Scotland on a low, proprietary basis.

UNITED STATES

In 1910 the equipments, faculties and facilities for instruction and courses given were reported by the Carnegie Foundation in detail for 148 colleges, with 3,395 professors, 4,637 other instructors and 22,208 students. The Council on Medical Education of the American Medical Association had already been striving for several years by publicity to make known to the people the conditions within the profession, in order to furnish the basis for correction. Naturally, the general public in the United States, as in other countries, had not interested itself very much in medical matters, from which it had been excluded through mistaken policy on the part of the profession. At the time of the beginning of the council's work there were 164 medical colleges in the United States and 178 in all the other countries of the world. In August, 1914, the total number of medical colleges in the United States had been reduced to 107, through the pressure of publicity, whereas the number of medical students had been reduced from the maximum number in 1904 of 28,142 to 16,502. It was high time that this important work was undertaken, since even yet the number of physicians in the United States seemed to be increasing. The number of registered physicians in 1914 was reported as 142,332 and the population as 99,451,000, a ratio of 1 to 693.

At the time the Carnegie Report for the United States and Canada was published, I am convinced that the best undergraduate medical schools in the world were to be found in the United States, as also the worst. Dr. Pritchett, president of the Carnegie Foundation, in one of his comments says:

> Faults of one sort or another may indeed be found in the medical schools of England, Scotland,

France, Germany and Austria, but scandals in medical education exist in America alone.

He also said:

If the lowest terms upon which a medical school can exist abroad were applied to America, three fourths of our existing schools would be closed at once. And, let me add, the remaining fourth would be easily and entirely adequate to our need.

The Carnegie Report was unsparing in its denunciation of dishonesty and disparaged incompetence. Whilst frank in criticism of the best institutions, it did not fail to encourage good features whenever and wherever presented. The very criticism was constructive.

The publication of annual reports by the Council on Medical Education of the American Medical Association, grading the medical schools into several classes, has had a far-reaching effect.

But it is seen that action was not initiated by the national or state official or governmental machinery, but followed all too slowly on the heels of the tremendous effort at professional house-cleaning begun by the American Medical Association. This movement was extended by the Association of American Medical Colleges and internationalized on an economic and social basis by the Carnegie Foundation, all three organizations cooperating to bring about the much-needed reforms.

The Council on Medical Education of the American Medical Association reports annually the result of all the license examinations conducted in each state by the state boards in tabular form so that the percentage mortality from each medical college is shown. This Council and the Association of American Medical Colleges cooperate in the inspection of all colleges, particularly the doubtful ones and both by private helpful suggestion and by public criticism are putting the moribund institutions to a painless end and encouraging those for which there is hope as well as need. Their work could be done far more efficiently, however, by an official federal board.

There is an increasing tendency in the middle and western states towards strengthening state universities which seems inevitable if education is to be regarded as a state function at all. Medicine as a quasi-public profession, which is becoming every day more important in the social-service machinery of the state, must look to the state for its training, which is now so costly.

CANADA

Canada, too, has had and still has her problems in medical education. The Carnegie Report being American born, has not dealt as fully with Canada as with the United States, nor has it ventured so far into criticism, constructive or destructive, as in the case of American institutions.

The Carnegie Report shows that in 1910 there were 6,736 licensed physicians in Canada, her population being 6,945,228, the ratio being 1 to 1,030. The statistics for Canada and Newfoundland for 1912 show a registration of 7,278 physicians, which in 1914 was reported as 7,577, the increase being much greater than the population requirement.

The congestion promised to be even greater before the war. To the eight medical schools a ninth has been added in Alberta. In 1914 there were 2,001 medical students registered in Canada, whilst in the United States there were 16,502, or only eight times as many, although the population was more than thirteen times as great.

It is surely time for the public to know what the profession has long felt, namely, that we do not need *more* but *better* doctors. If Flexner, after careful study of conditions within and without the profession, regarded it as highly overcrowded in

Germany where there was an average of 1 physician to each 1,900 of population, he certainly was justified in believing that the United States had reached an unstable condition of affairs, since her ratio is 1 to 693, showing nearly three times as much overcrowding as in Germany and nearly twice as much as in Great Britain. Canada, before the war, was more overcrowded than any other country except the United States, her ratio being 1 to 984. As judged by the overwhelmingly large number of registered medical students, she bade fair in the near future to outstrip our neighbor.

Probably, however, the vast spaces of Canada require and will continue to require more medical men per unit of population than the older countries, particularly if she is to cure herself of that world-wide infection whose pathognomonic sign is "let the other man produce," and whose final stages are rural atrophy and urban hypertrophy.

In adapting supply to demand, the medical profession must not only continue to heal and prevent, to practise and to preach, but will be compelled to understand and to help solve those problems which are born of poverty and crime as a consequence of their relations with disease.

Specialization will be increasingly necessary to enable the individual physician to keep up with advance in knowledge. Post-graduate study in a system of continuation schools will be imperative and each state or provincial university will be shirking its duty if it does not cooperate with every other existing local agency in fostering and developing all available facilities.

With specialization comes inevitable demand for cooperation of the specialists and the group system may be expected to replace individualism. The splendid plan evolved by the Mayos, adapted to various environmental requirements, shorn of weaknesses and moulded on an increasingly public and decreasingly corporational basis, will spread. Contract work of groups on a public-service basis seems inevitable if the health and well-being of individuals is to be, as it must be, a matter of public concern and fundamental to national efficiency. The rural and sparsely settled districts need the best, not the worst, medical services and can not be ignored. This means increased importance of public medicine and expenditure of the funds of the wealthier districts through governmental administrative channels for their protection against the neglect or disabilities of the poorer districts, just as is now the case in educational expenditures. We must level up and not down, for we are indeed our brothers' keepers.

In the great influx of foreign population which may be expected on the cessation of the war, it is presumed that foreign physicians will also be amongst the newcomers. Rapid transit, ease of communication and all other annihilators of space conspire to make medicine, like commerce, international.

For these reasons and also because of the lessons to be learned I have ventured to direct your attention to a few of the conditions surrounding medical education in certain European countries.

In the Canadianizing and Americanizing of the millions of people whom we expect to come to us, we must have definite standards and we ourselves must expect changes in our existing standards and ideals, if we are to profit by the best which the newcomers bring us, eliminating our own worst features and placing a prohibitive tariff on theirs.

Of design, I have stressed the consideration of American conditions. The United States had at one time perhaps the worst medical training in the world and also the

best undergraduate medical teaching in its institutions. So she represented the two extremes.

As a result of publicity, the best schools have seized the psychological moment to improve themselves. The very worst schools are no longer existent. The United States availed itself of short cuts impossible to the older countries. It is therefore the part of wisdom for Canada to learn what can be gleaned from your recent wholesale changes, which are nation wide.

Our new country can save herself scores of years, and the pain and mutilation of those capital operations required in the older countries may be avoided by the exercise of care and foresight in this stage of her development.

A recent statement by Professor Adami, of McGill University, on the occasion of the inauguration of the president of Manitoba University, was startling, coming as it did from one who was born and trained in Great Britain and who has become the medical Nestor of Canada and the medical philosopher of this continent. In his address on medical research he called attention in detail to the advance of medical investigation and research throughout the world and laid emphasis upon recent developments in America, and perhaps on account of his innate modesty, particularly in the United States. He said:

> The center of medical research and education is moving rapidly westward and is now on this side of the Atlantic Ocean.

In view of our free hand and the twentieth-century tools available, we shall be wise to approach our task with care. That task can not be undertaken from a purely medical standpoint. There is no such thing. It must comprise a general educational betterment, a national, in fact a world program. We must adjust our public educational institutions so that the boys and girls are trained for practical affairs without loss of cultural and esthetic values. It is, after all, the manner of the teaching and the study as also the character and timber of the teacher and pupil which make for culture and efficiency. Knowledge is none the less scientific because of its possible application nor less cultural if useful. Our primary schools must be continuous with the high schools. Industrial schools must be established and the demands of agriculture can not be evaded. All of these must articulate with each other and with the university, so that at whatever point the pupil may be required to go out into his life's work, he may be as fit as he can be made in the time spent in fitting.

Continuation schools which cooperate with the public school system on the one hand and with the line of industry, commerce or professional work chosen by the pupil on the other must be provided, so that education becomes continuous for life and not a passing phase.

Systematic graduate work is just as necessary in order to keep medicine, law, theology, agriculture, commerce, journalism and the other professions in touch with the newer developments as is undergraduate training. University extension work which enters into all the activities of the people is growing in Great Britain and has been organized in many of the states of the union. Dr. Pritchett's statement is pertinent. He says:

> Education in any nation is one thing, not a series of separate and unrelated things.

Suitable exits from the educational system must be provided into the walks of life as well as into university courses and industrial schools. Studies in language on the whole should be begun earlier and continued longer, so that the student may be in a position to get some reward from his struggles with the dictionary and grammar

through an insight into literature and history. At the same time this would free the boys for studies in the basic sciences and the girls for similar studies and work in household economics and home-making and such other practical work as begins to appeal to them in the last years of high school.

In medicine the basic sciences begun in the high school should be continued in the university and constitute the chief object of the first two years' university training, which should be required for entrance into medicine. The studies should probably include, judging by your own observations on modern trends, physics, chemistry, biology and a reading knowledge of German or French, whilst advantage should be taken of the elective system to choose work in economics, sociology and human relationships, including the obligation as well as the rights of the ordinary citizen. Psychology should be available either here or as an elective in medicine after the foundation has been laid in the anatomy, physiology and pathology of the nervous system.

Considerable discussion has arisen over the demand of some American universities of the bachelor's degree in arts or science as a prerequisite for medicine. Harvard and Hopkins were the leaders and certain other universities have followed. However desirable it might be to medical students to take a previous arts or science degree, we must not forget that the rapid accumulation of knowledge concerning the science and art of medicine calls for a lengthening rather than a shortening of the medical course itself. Even with the increase in longevity which we fondly expect, we have to recognize that there is a limit to the formal training period. We must be practical and can not expect to spend longer time in training than the prospective doctor expects to spend in practise.

There is some sentiment for the inclusion of the so-called medical sciences, anatomy, physiology, pathology and bacteriology, with the arts or sciences in the university rather than in the medical college. This view is debatable. In any event, on the conclusion of the two years of work in the university preliminary to entering into medicine, plus the two years' work in anatomy, physiology, biology, chemistry, bacteriology, pathology, etc., the student is deserving of a bachelor's degree in science. Even should he discontinue his medical studies at this point, he has completed a course which fits him for work in many other directions and which has as great cultural and scientific value as many others which he might select for a science or arts degree.

Certain of the Canadian universities and some of the American, such as Minnesota, grant the B.A. degree to those who have completed three years in arts, inclusive of the sciences, modern language, etc., when the students have completed the first year's work in anatomy, physiology, bacteriology, etc. Such a course is to be recommended for the young man or woman who has the time or inclination for it.

In passing from one year to the next, certain students, deficient through illness, lack of application or other causes, may be saved the loss of a whole year by providing summer or vacation courses. These are very useful too, for migrants from other colleges, whose curricula are not identical with that of the new institution. On the whole, the best and most economic plan has been devised at the University of Chicago with the four-quarter plan, whereby the university is in continuous session. Modern economic efficiency demands that expensive plant and equipment be used to their fullest capacity. The human element, *i. e.*, staff and students, alone require rest.

In regard to the training of the clinical

years, the present trend is toward full-time clinicians, as it has been toward full-time laboratory men for the medical sciences, thus placing the whole university mechanism on a university footing. Johns Hopkins University has been the leader in this as in many other phases of medical teaching. Medicine, surgery and pediatrics have been placed on a full-time basis and the professors are not allowed to engage in private practise. Pay patients may be treated by them in Johns Hopkins Hospital, the fees going to the support of the hospital, the professors being entirely dependent upon their salaries or private incomes. This is the most drastic step taken by any university in the world, not excluding Germany. Meanwhile the world looks on and if it is wise, reserves judgment.

Dr. S. J. Meltzer, of the Rockefeller Institute, in SCIENCE for October 30, 1914, has a most interesting and important article on "Headship and Organization of Medical Departments of First Class Medicl Schools." He proposes to attain the ideal not by revolutionary steps because he says "Accelerated evolution gives better and safer results than revolution." For the clinical chair he proposes:

1. A head for this position, for whom the position should be his main occupation;

2. Two, three or more paid scientific assistants, for whom this position should also be their chief occupation;

3. Several professors and associate professors, etc., for whom these positions will be secondary occupations, their chief occupation being their private consultation or family practise. Some of these may receive moderate salaries;

4. An unlimited amount of unpaid volunteer assistants.

He thinks that all these positions should be appointments limited to varying periods of years.

He thinks the head should give about eight hours a day to his main calling and that they should be his fresh hours, say from 8 A.M. to 4 P.M. After these hours he may do with his time as he pleases. "But he should have no private patients in the hospital in the department of which he is the head."

Proper clinical teaching is only possible if teaching institutions own or completely control hospitals which are ready to discharge their double function. This double function involves the care of the patients of to-day and, not less important, the better care of the patients of to-morrow through teaching and research. Hospitals should not be simply boarding houses for the sick but institutions for research, study and teaching. Fortunately both these ends, viz., care of patient and teaching, are best served by the same plan.

The best results are obtained where the university owns its own hospital which is conducted primarily as a teaching and research institution. This safeguards at the same time the best interests of the patient. By arrangement with municipal and other public bodies, university medical schools may assume sole responsibility for the professional conduct of municipal or semi-private hospitals, guaranteeing the best possible service, but such hospitals can not easily be made integral parts of the teaching plant of a university. They should be accessory. Provinces and states will find the truest financial economy in coordinating their state universities with state hospitals and other state institutions of all kinds. Around the state university may be grouped the state hospital for the care of medical, surgical, obstetrical and special cases; one or more of the state institutions for the cure of tuberculosis and the care of the incurable, and a state receiving department for the observation and classification

of acute mental cases preliminary to assignment to the state institutions for the insane. All of these institutions, including correctional and charitable organizations as well, should be mutually related to each other and to the university, so that the experts of each may be available for all.

The governmental public-health mechanism should take advantage of the university experts in investigational and research work for legislative and administrative control. This is applicable also to other departments of the government. The university activities should be limited, however, to teaching, investigation and research and should stop short of legislation, administration and police control.

It seems certain that we can not compress the training of the physician of to-morrow into less than a four-year high-school course, plus two years of university work which shall include the basic sciences and a modern language, plus two years of medical science, and two years of clinical instruction, followed by a compulsory year in an approved hospital in interne service. Minnesota was the first school in the United States to take this step. At the conclusion of such training, the student should emerge with his arts or science degree and the medical degree.

We are now confronted with the matter of licensure, the ultimate safeguard which the public should demand for its own protection in addition to the standards of teaching which it enforces in its own provincial or state universities. A federal licensing board is best. It, like all licensing boards, however, should provide searching practical examinations in addition to written and oral tests.

The examination conducted by many of the state medical licensing boards is farcical in the extreme. The appointments are given all too frequently for political or personal reasons to men who are unfitted by natural aptitude, training or temperament for this exacting work. The United States might well take a leaf from Great Britain's book with respect to the conduct of examinations for licensure, whilst the latter might follow, with profit, the example set by this country in the matter of improvement in medical teaching.

Such boards should demand, as a minimum the amount of training specified above. The constitution of the board is a matter which requires careful thought. In the long run, I am convinced that the responsibility for its personnel should be placed upon the government and not upon the profession. If we are to avoid the public and private suspicion that the medical profession is a sort of trades union, the appointments should be made by the government. If our system of government is sound, this is the logical step. If not, our government needs change and we, as citizens, have been neglecting our duty. The prime consideration is that the standards of medical teaching and medical licensure are for the protection of the public and not for the protection of the profession. Licensing boards must take account of the teaching institutions in their own and other countries, and some governmental, in fact international, clearing-house arrangement be made for the careful inspection and accurate report to all the world regarding the facilities, equipment and standards which exist in all countries. A state or province or country can protect itself best from undesirable additions to its medical profession from other communities and other countries by insisting upon one standard for all.

In view of the present trend towards the socialization of medicine and the increasing importance of public health, together with the over-supply of physicians, immediate attention should be paid to the training of public-health workers and the development of adequate public-health machin-

ery, which provides work, pay and authority commensurate with the responsibilities which the workers are expected to assume. It means training in the sciences fundamental to medicine, in diagnosis and in certain branches of sociology, law, economics, engineering, etc., and can not be undertaken in a medical school but in a university which has full faculties and in a state or province where all public institutions are coordinated and work in cooperation.

The history of Johns Hopkins Medical School is significant. Medical teaching there grew out of the graduate medical teaching which had developed in the hospital.

Our faces are turned toward public medicine. If the profession accepts this as inevitable and also desirable and the public realizes its opportunity and responsibility, the change may be brought about as an evolution, rather than as a revolution. Instead of developing more medical schools to meet a demand which does not exist, society should unite in strengthening those which have shown a progressive spirit and some realization of the medicine of to-morrow. The rational evolution of the medical school would be the development at universities which are adequately equipped, of schools of public health in which all of the faculties of the university participate. It simply means the re-grouping of certain existing university departments as a committee under the name of a "School of Public Health." New universities have a particularly good opportunity in the foundation of such schools to help orient some of the medical graduates, who have failed in practise to adapt themselves to present conditions.

Our overcrowded profession has in it many men who would welcome the opportunity to secure freedom from the commercial aspects of practise. Many are better fitted for public service than for private practise. Such men could be trained by such a mechanism, for certain phases of public health administration. Others, for their own sake and the sake of humanity should receive further training in the practise of medicine and others should be excluded from the profession for which they are unfitted, or have failed to fit themselves. It would be some time before *all* of the present graduates in medicine could be intelligently utilized. When the demand has caught up with the supply and new medical schools are required, they will naturally evolve from such graduate schools, in this case of public health, instead of as the Hopkins did from a graduate medical school. Such public health schools would inevitably become more specialized and if private practise, as we have known it, persists, it could be logically related to and become the natural outgrowth from such public-health colleges.

Our profession has to play the part of social pioneer in demonstrating the inevitability of specialization and the need of cooperation between and coordination of specialists. We have not realized, however, that all of the workers in the medical field do not require and should not receive the same training. The public has long recognized that a short course of three or four months is insufficient for the training of specialists and there is an increasing interest within and without the profession in the development of adequate facilities for graduate training of those who desire to enter a particular medical field, *i. e.*, to become specialists. If an additional training period of two or three years is required for such a purpose in addition to the six to eight years required now by various medical schools and licensing boards, it is clear that great expenditure of time and money is demanded of the would-be specialist and he has a right to expect a fair return on his investment. Will anything less than

free opportunities for training and the entire taking over of medicine by governmental mechanisms, solve these difficulties, is a question which many are asking.

It seems that it would be most easily possible to coordinate the different elements in medicine in groups on a governmental, rather than a corporation basis.

It is necessary to provide each community, no matter how remote, with a group of trained medical men in which each special field is covered and the work of each properly related to the others.

The general practitioner and the family doctor seem doomed to disappear. No single individual can hope to keep abreast of new knowledge in all branches. Such a plan is for the best interests of the individual, the public and the doctor, and is in line with the trend of the times, which seeks to make of each citizen an expert in an increasingly circumscribed field. An agreement could easily be made whereby each member of the group in turn could get away to some of the continuation schools to bring himself abreast of the latest advances in his chosen work and carry back inspiration to his colleagues.

Whether this group system is a part of a municipally or a state or a nationally controlled mechanism can not be foreseen. Whether it will evolve through a corporational or state health insurance can not be foretold. Life insurance companies, railway and mining corporations and other similar organizations are drifting into makeshift arrangements which have these objects in view. In any event commercial concerns are realizing a little of the huge tax on the world of sickness, and the increasing load which the well assume in caring for the state dependents.

If medical school inspection is such a good thing, why should it not be extended to embrace society as a whole?

As this group system develops, it will be found that all the members of a group so constituted will not require the same training nor will some of the individuals require to be trained as long as certain others. For instance, all might have the same basic training, and employment could be found under competent supervision for those with the minimum training until such time as they had opportunity to demonstrate aptitudes. They could then be returned for certain formal training to graduate institutions so as to fit them for the new line to which they aspire and for which they have shown capacity. This would be a sort of continuation school in medicine whereby the original medical science instruction in laboratory, in clinical and in various public health phases could all be related to each other and to practise.

No one of us can see clearly the outcome. He sees indications of a coming change and, in many instances, instead of adapting and preparing himself for such changes, resents them. Here is an opportunity for medical leadership. The public has been aroused. We must not fail to rise to the opportunity and meet the obligation.

The abolition of sectarian ethics and the adoption of one brand, based on the Golden Rule, will cure many of the ills of humanity. In passing, we may ask ourselves why we should have one standard of personal ethics, another for professional and business purposes and yet another for political ends. Why, when owing to specialization, each group becomes increasingly differentiated from other groups of workers and at the same time increasingly dependent upon them, should the members of a group so often stand by their fellows in that group against the best interests of all the groups? That medical men have stood together, quite often against the best interests of other social groups, has estranged and insulated them to such an extent that they

have lost individual and collective power in their attempts at the solution of the problems of society. This has, at the same time, been to their economic disadvantage.

Medicine is founded on the highest ideals which inspire human action. Its traditions are of the noblest. The relation of the patient to his physician is sacred. Nearly every individual looks upon some member of the profession as almost divine. Yet the public, which is composed of just such individuals, has been suspicious of the profession which has in it many hundreds of just such physicians. We realize that in order to cure, as well as to prevent disease, it is necessary to deal with humanity one at a time. Yet to-day we are facing, as never before, the problem of harmonizing the individual's obligations and rights with collective needs and mass efficiency.

The greatest asset of the individual, as of the mass, is physical efficiency. Yet we can not solve our present problems in terms of the medicine of the past. The physician's problem, as it involves himself and others, is not medical alone, or economic alone, but social. We physicians have to return to the ideal of our fathers in medicine, which is that of service. We must go on in our search for new means of preventing and curing disease. We must employ these means for the benefit of humanity. In our interest in the details of this work, we must not lose sight of the increased complexities of those whom we seek to serve. We must either adapt ourselves and our profession to the ever-increasing needs of humanity, or expect that they will be adapted for us by others, who are less sympathetic with our traditions and aims. We must not stand aloof. We must develop leadership within the profession, which is only possible to those who understand the spiritual, intellectual, social and economic needs and problems of those whom they may seek to serve as well as they do their physical ills.

The day for American leadership has dawned. If she realizes it she may go further than any other country has yet been able to go, and one of her greatest opportunities is in the orientation of medicine with other social forces.

To her is proffered the honor of gaining universal recognition of medicine as the highest calling whose motto is "I serve." Will she accept it? Has her medical profession the needed vision and strength? Will her people receive such leadership kindly?

The agony which the world is enduring will have been suffered in vain if we can not learn how to develop the best that is in each of us for the advantage of all. Is not the world at war to determine whether the greatest right of every man is that of serving others, or of being served? We are now adjusting our perspective of obligation on the background of individual right.

F. F. Wesbrook
University of British Columbia

DEDICATION OF THE NEW MUSEUM BUILDING OF THE CALIFORNIA ACADEMY OF SCIENCES

The dedication of the new museum building of the California Academy of Sciences and the formal opening of the museum to the public occurred on Friday afternoon, September 22. The dedicatory exercises were held in the California Mammal room, a hall 180 feet long by 60 feet wide.

Mr. C. E. Grunsky, the president of the academy, presided. The invocation was by the Right Reverend William Ford Nichols, bishop of California. Brief addresses were made by the following: Mr. William H. Crocker, president of the board of trustees; Mr. C. E. Grunsky, president of the academy; Mr. Edward Rainey, for the mayor; Mr. George Haviland Barron, curator of the Memorial

Museum, San Francisco, for the board of park commissioners; Dr. David Starr Jordan, chancellor emeritus, Stanford University; Dr. Barton Warren Evermann, director of the museum.

Mr. Crocker spoke feelingly of his long connection with the academy, as president of the board of trustees continuously since 1898, or 18 years. Before him his brother, Charles F. Crocker, had occupied the same position for a number of years and his father, Charles Crocker, was deeply interested in the academy.

As president of the board of trustees, Mr. Crocker formally dedicated the new museum building to the advancement of the biological and physical sciences and the educational interests of the city of San Francisco and the state of California. He then turned the building over to the academy.

Speaking of the history and the aims and ambitions of the academy, President Grunsky said, in part:

Organized in 1853, the California Academy of Sciences has now for 63 years been conducted along broad lines for public service. Membership in the academy at a nominal annual fee is open to all who are interested in the study or advancement of science. Its activities are directed mainly along educational lines in providing the material and opportunity for securing information on matters pertaining to the natural sciences; and second, along lines of research and study in the various subdivisions of the natural sciences.

There are those present to-day who will recall, and some who were active in, the activities of the academy while it was quartered in a building at the southwest corner of California and Dupont streets, and there are many here who have enjoyed and who have profited by the natural history museum and its accessories maintained for many years prior to the great disaster of 1906 on Market between Fourth and Fifth streets.

It would be needless to present at this time a review of the history of the academy and of the work done by it. Those who desire will find much of interest and of value in the published records of the academy's proceedings.

It would be futile to give a due mead of credit to those heretofore connected with the work of the academy whose contributions have borne fruit, and whose achievement is expressed in some measure in the museum plant now to be brought closer to the general public. It must suffice to say that at all times in the history of the academy there was a group of enthusiastic scientific workers—with changing personnel—who stood ever ready to make, and did make, the sacrifices and put forth the personal effort which made the work of the academy worth while.

In the matter of publications, as in the case of its other activities, the academy has had to accept the limitation upon its output made necessary by the lack of adequate funds. Much has been left undone which ought to be done. Time will not, however, permit me to take up this matter for full presentation. Let me call attention merely to one fact which will be patent to all who look carefully into the affairs of the academy. The field in which the academy is active is but imperfectly covered; nor can it be covered as it should be without adequate support from those of means who, in furthering the aims of the academy, will not alone be benefiting our city and commonwealth, but will be contributing to the sum of human knowledge.

The building which has here been erected and is to-day being dedicated is located upon public ground. The academy has invested in it $183,000. Yet this building, while it is an earnest of what the academy is willing to do for the public, represents, in area occupied, only about one third of that of the museum building, which we hope some day in the near future will be completed on this site.

To accomplish the incomplete work with which we desire you to become better acquainted, the academy has taxed its resources as far as seemed wise and has made it possible to open to the public, housed in the first unit of its museum building, certain exhibits which will forecast what it is hoped may ultimately be adequately accomplished. There should be here assembled material from the Pacific Ocean and its shores representative of all the natural sciences, more complete than can be found elsewhere. It can be done and will be done, but not without outside aid. The resources of the academy, chiefly the result of bequests and endowments that will be referred to later, are limited and our installations and facilities for housing material always obtainable in abundance must progress slowly unless the academy can count on the generous assistance of those who have the means.

We can not at this time announce when our building will be extended. More material for re-

search and exhibition has already been collected than we can properly display. Some of the most striking habitat groups that should be at once installed must wait until more funds are provided and in some cases until the time has come when we can add to the building.

It has been suggested that the academy should extend its activities by assuming the management of an aquarium. I think I speak for every member when I say that the academy is ready to do this. But even though there are those of our citizens who may be willing to erect and equip the necessary buildings the academy is not so circumstanced that it can provide the funds for maintenance and operation. But its staff and its organization including the services of its director of the museum, Dr. Evermann, an expert in matters relating to fishes and the fisheries, are ready to help and will help. San Francisco should have an aquarium filled with the life of the Pacific Ocean and of the streams discharging into the ocean, second to no other aquarium in the world.

The academy has asked you to be present to-day at this dedication of the first unit of its museum building in order that you may become better acquainted with the academy's aims and purposes and as a reminder to the public that the academy is here to benefit and serve the whole community.

It is appropriate that at this time attention be called to the generous aid which the academy has received in the past and to that which it is now receiving in its plans for an enlarged field of usefulness.

It should be remembered that the academy is in Golden Gate Park with the consent of the people of San Francisco, who have seen fit to increase the academy's opportunity for service by permitting the erection here of the necessary museum buildings. This consent was given in 1910 and ever since that time the plans have been under consideration and in execution which are to-day beginning to see fulfillment.

By bequest of James Lick forty-one years ago, the academy became the owner of the Market Street property between Fourth and Fifth Streets on which for many years a museum of natural history was maintained. This property now in use for business purposes is the academy's present main source of income. The Lick bequest is now carried on the books as an asset of $802,000.

In 1881 the academy received from Mr. Chas. Crocker an endowment of $20,000, the income from which is to be used in aid of scientific research.

Mr. John W. Hendrie in 1899 bequeathed to the academy the sum of $10,000, the income from which has been set apart for the publication of scientific papers.

The late Wm. Alvord bequeathed to the academy the sum of $5,000, to be used in improving and adding to its herbarium.

During the last decade, while husbanding its resources, and collecting the material which is now assembled in the building being dedicated to-day, the academy affairs have necessarily received but little publicity and there has been but little opportunity for the public to become acquainted with its activities; nevertheless, the academy has been selected by many who have collected material of scientific value as the proper institution to preserve the same and make it available for the public. Attention will be called to only a few recent donations the announcement of which is appropriate on this occasion.

Our generous public-spirited fellow citizen, Wm. M. Fitzhugh, has, by purchase and additions thereto, preserved in its entirety the collection of Indian baskets, ornaments, implements and related material made in their lifetime by the late Professor and Mrs. T. S. C. Lowe, of Pasadena. This collection of exceptional interest and magnitude, which would otherwise have been scattered and would have lost value by piecemeal sale, is on display in the academy museum as a loan and merits your careful attention.

The most important gift which the academy has recently received is that of the Henry Hemphill collection of marine, freshwater and land shells. This magnificent collection, the making of which engaged the attention of Mr. Hemphill during practically all the years of his long and useful life, and which contains between 60,000 and 70,000 specimens representing more than 12,000 species, has been donated to the academy by Mrs. Charlotte Hosmer, daughter of Mr. Hemphill. The academy feels grateful to Mrs. Hosmer for this most generous gift.

The installation of the bird-habitat groups which are to-day being opened to your inspection and which will contribute much to the education and enjoyment of the public has been made possible by the liberality of three other San Franciscans as follows:

Mr. Wm. H. Crocker has presented to the academy the Farallon Islands bird group.

Mr. J. D. Grant has presented to the academy the San Joaquin Valley bird group.

Mr. W. B. Bourn has presented to the academy the Desert bird group.

It is their wish, as it is the wish of every one in any way connected with academy activities, that these exhibits, and the others, now to be opened to public view, may prove instructive and inspiring and a source of lasting enjoyment to all of those who care to avail themselves of the privilege, open to all, of visiting the museum.

To these donors and to all who have contributed to the service value of the academy, the academy, through its president, expresses its sincere appreciation and gratitude.

The academy welcomes such aid in the accomplishment of its aims and will ever be ready to accept and manage any trust having in view the advancement of science.

Mr. Rainey, representing the mayor, and Mr. Barron on behalf of the board of park commissioners, spoke of the great benefit which the museum of the California Academy of Sciences will be to the people of San Francisco. The location of the museum in Golden Gate Park, the most beautiful "people's playground" in the world, is a guarantee that it will be visited not only by our own people, but by all who come to San Francisco.

Dr. Jordan spoke of the value to general education and to science of natural-history museums. He called attention to the eminent position already attained in the field of scientific research by the California Academy of Sciences, and the prominent place the academy is destined to fill as a scientific educational institution.

In a reminiscent way, he told of his many years' connection with the academy, as president in 1896 and 1897, and again in 1900 to 1902, of his first visit to the academy in 1879, and his pleasant meeting at that time with W. G. W. Harford and Dr. Albert Kellogg the botanist and one of the founders of the academy.

Dr. Evermann spoke in part as follows:

In the few minutes allotted to me I shall be able to speak briefly of only one or two of the museum's activities and aims.

The California Academy of Sciences is a scientific, educational institution. As a scientific, educational institution, the academy, through its museum, has two important functions. The first of these is that of *scientific research*. The museum must furnish men and materials and facilities for scientific investigation. Through its research collections and its field investigations, it must study and solve its share of the multitude of scientific and economic problems which the physical and biological sciences, particularly those presented by the zoology, botany and geology of western America and the broad Pacific. We must do our share in studying and investigating and making known the natural resources of our country. The academy must contribute its share to the world's contributions to human knowledge.

The second important function of the academy is *educational*. The academy must do what it can within its means to be of real service in an educational way, not only to the general public, but also to the public and private schools.

One of the ways in which it is endeavoring to render educational service is by installing in this museum habitat groups of Californian mammals and birds and other exhibits that possess real educational value and which show the natural resources of the state.

Scientific research requires money and men. Habitat groups such as we are able to show you to-day also cost money.

The income of the academy is limited; it is not sufficient to enable the museum to carry on the scientific work which it should do and also build up popular educational exhibits.

We have been able to prepare the splendid exhibits which we have to show you to-day because of the generosity of a number of public-spirited citizens of San Francisco and by curtailing somewhat for the time being the scientific activities of the academy. Without the help of these friends of the academy the valuable and attractive exhibits we have now installed would have been fewer in number. Nor would there have been so many if we had not drawn upon the academy's funds for scientific research.

We have planned for several additional large habitat groups. We even have the animals on hand for a number of them. I may mention the very interesting elephant seal, a remarkable species of large marine mammal now nearly extinct. We have the animals for the group, but need funds for installing them. We have also the animals for two or three deer groups, a gigantic tortoise group, and a large iguana group. We have planned also for 22 groups of small California mammals, a dozen small bird groups similar to the very beautiful California quail group which you will see in the bird hall, and an indefinite

number of small portable habitat groups such as that of the western meadowlark, which may be seen in the office upstairs. These we propose to loan to the public schools should they desire them.

It is hoped that the necessary funds for these exhibits may be supplied by private donations, so that the net regular income of the academy may be reserved chiefly for scientific research. The large groups cost from $3,000 to $4,000; the small groups about $500 each; and the portable educational groups about $100 to $250 each.

It is hoped that this opportunity to do something worth while may appeal to those who are interested in education and who have the means to help along in such excellent work. What a splendid thing it would be for San Francisco and the state if, among those present here to-day, there might be some so impressed with the opportunity to help in this good work that they would provide the means to enable the academy to add a dozen or more groups to the excellent series so well begun. We have the expert taxidermists and preparators to do the work; we need only the funds to meet the expense.

In conclusion, may I be permitted to mention one other need of the museum, to which I have called attention on another occasion.

It is my ambition that there shall be in this museum a *Children's Room*—a room in which will be displayed natural history objects such as are particularly attractive to little children. There would be in this room brightly and curiously colored birds and butterflies, moths and beetles and other insects; curious animals of other groups; attractive minerals, growing plants, and aquariums with interesting and instructive animal and plant life; colored transparencies of beautiful native flowers, all selected and arranged with reference to the telling of an interesting story, of teaching a definite lesson.

And there will be in this children's room a children's reading room in which will be found a library of all the interesting and reliable nature books and helps to nature study.

And there will be in charge of this children's room a well-educated, kindly, sympathetic man or woman who knows animals and plants; who knows the specimens in the museum and the live things in the park about it; and who, above all, knows and loves children; a man or woman who can wisely direct the observation and the reading of the children so that they may correlate their reading with what they have seen in the museum or in the open, and thus increase rather than stifle their interest in, and love for, animate things, as our public schools almost invariably do. It will be arranged so that children of the different grades will come to this room at different hours, and receive the instruction and help and encouragement adapted to their respective needs.

And all this will be done and done soon, I confidently believe. It will be done because it so evidently appeals to us all as being the *right thing to do*, the right sort of education and training to give our children. It will be done, because the beauty and worth of it all, for the little children's sake, will appeal to some one who has prospered in this world; some one with a kindly heart, who loves children, and who wants to help them to become the men and women they should become; and some day that man or woman will come forward—I wish it might be to-day—and, out of his abundance, endow a *Children's Room* in this museum, and thus make it possible for the California Academy of Sciences to do this splendid work for the children of California, not only of to-day but for those of the years to come.

At the close of the formal dedicatory exercises a private view of the exhibits thus far installed was afforded the museum's guests, of whom nearly one thousand were present in response to the special invitation.

Large habitat groups have been completed of the following: San Joaquin Valley elk, black-tail deer (summer scene), mule deer (winter scene), antelope, desert mountain-sheep, leopard seal, California sea-lion, Steller's sea-lion, mountain-lion, black bear, raccoon and striped skunk, coyote, Farallon Islands bird rookeries, San Joaquin Valley water-bird group, and a desert-bird group. A California condor group is nearly completed, and small groups of the California Valley quail and western meadowlark have been finished.

A number of additional groups will be installed in the near future, as materials and funds become available.

That the museum of the California Academy of Sciences has at once taken a prominent and secure place in popular favor is evidenced by the phenomenally large attendance following its formal opening to the general public on Sunday, September 24, when 9,812 visitors were recorded. On each of the week

days following, the attendance has exceeded one thousand. The museum will be open to the public from 10 A.M. to 4 P.M. on week days and from 10 A.M. to 5 P.M. on holidays, including Sundays.

BARTON WARREN EVERMANN

SCIENTIFIC NOTES AND NEWS

THE National Academy of Sciences will hold its autumn meeting in Boston and Cambridge on November 13, 14 and 15. The William Ellery Hale lectures will be given on Monday evening and Tuesday afternoon, by Professor Edwin Grant Conklin, of Princeton University.

THE first lecture of the Harvey Society for the present season was given on October 14, at the New York Academy of Medicine, by Dr. J. S. Haldane, F.R.S., of Oxford on "The New Physiology." This lecture will be printed in SCIENCE.

THE degree of doctor of laws was conferred upon Thomas A. Edison over the telephone by Dr. John H. Finley, president of the University of the State of New York, at the closing session of the institution's fifty-second convocation on October 20. Mr. Edison was in his laboratory at Orange, N. J., while Dr. Finley was in the auditorium of the New York Education Building.

DR. GEORGE W. FIELD, of Sharon, Mass., chairman of the Massachusetts Commission on Fisheries and Game, was elected president of the American Fisheries Society at the concluding session of its forty-ninth annual convention, held in New Orleans on October 18.

DR. PERCIVAL LOWELL, of Boston, director of the Lowell Observatory at Flagstaff, Arizona, has been elected an honorary fellow of the Royal Astronomical Society of Canada.

MR. LOUIS R. SULLIVAN and Mr. Leslie Spier have been added to the scientific staff of the department of anthropology of the American Museum of Natural History. Mr. Sullivan will care for the skeletal and other somatological material in the department and will develop exhibitions showing racial differences and man's relations to the primates. Mr. Spier for the present will care for the archeological and ethnological collections exhibited from the eastern states.

WITH the cooperation of Harvard University and the Massachusetts Institute of Technology, the Barber Asphalt Paving Company has established at these institutions a fellowship for research in asphaltic materials and their uses. The fellowship is to be known as "The Clifford Richardson Fellowship." Mr. Richardson is an alumnus of Harvard, known for his contributions to asphaltic highway construction and the chemistry of bitumens.

PRACTICAL forestry management has developed to such proportions in Massachusetts, under the administration of State Forester Rane, that it has been decided to establish a state forestry office in the western part of the state for the convenience of land owners in that section. C. R. Atwood, who is a graduate of the University of Maine, and for some time has been an assistant to Paul D. Kneeland in the Boston office of the state forester, has been selected for the position. He will have headquarters in Springfield.

S. B. FOX, Ph.D. (Cornell), has been appointed assistant in farm management on the experiment station staff of the Montana State College.

THE American Museum of Natural History had three expeditions for fossil vertebrates in the western United States during the past summer. All report a fair degree of success, especially in the discovery of new and interesting fossil faunas. Mr. Barnum Brown, in charge of the expedition for Cretaceous dinosaurs in Montana, reports the discovery of Cretaceous dinosaurs distinct from those of the localities hitherto explored by the museum, and perhaps representing an older stage in their evolution. Mr. Walter Granger reports the discovery in a new locality in New Mexico of numerous remains of small mammals of an age intermediate between the Torrejon and Wasatch horizons. Mr. Albert Thomson has continued work in the Agate quarry, securing additional material needed for the group planned to represent this quarry fauna and has also secured interesting material from the Pliocene beds

farther south. Dr. W. D. Matthew was with Mr. Thomson's party during the early part of the season, engaged chiefly in an extensive reconnaissance of the later Tertiary fossil beds in western Nebraska. Professor H. F. Osborn joined the party for a short time, visiting on his way some of the more important localities in Nebraska.

The University of Chicago paleontological expedition to northern Texas the past season, which was in charge of Mr. Paul Miller, of the department of geology and paleontology, secured some valuable material, which is now being prepared for exhibition in Walker Museum. Mr. Miller was accompanied by Messrs. Jillson and Bridge, fellows in geology. The most important of the specimens are several nearly complete skeletons of *Labidosaurus*. In northern New Mexico Professor S. W. Williston and his son spent several weeks exploring the Permian deposits along the Puerco River. He brought back the skull and a large part of the skeleton of a large carnivorous reptile, *Sphenacodon*. Dr. Williston also secured most of the skeleton of a smaller reptile, perhaps five feet in length, which is new to science.

The expedition from the American Museum of Natural History to Nicaragua, under Messrs. Clarence R. Halter and L. Alfred Mannhardt, will remain in the field until January. Scientific collections of reptiles and fishes have been made from the eastern coastal belt—and shipments north of living specimens of *Basiliscus* and *Caiman* are being prepared for use in the reptile group work of the museum. The expedition will now carry the survey into the mountains of the interior, to Lake Nicaragua, and the western coast.

"Aspects of Modern Science" is the general subject of a series of lectures being given under the auspices of the University Lecture Association in cooperation with the University of Chicago. In the Oak Park center of the association, on October 16, Professor Edwin Oakes Jordan, chairman of the department of hygiene and bacteriology, gave the fourth lecture in the series, on the subject of "Bacteria and the Prevention of Disease." On October 25 Associate Professor William D. Harkins, of the department of chemistry, spoke on "Radium, the Breaking-up of Atoms, and the Evolution of the Elements." The final lecture in the course will be that by Professor Rollin D. Salisbury, dean of the Ogden Graduate School of Science, on the subject of "The New Geology." The series was introduced by Professor Robert A. Millikan, of the department of physics, who discussed "Modern Views of Electricity."

At University College, London, a series of six public lectures is being delivered by Professor J. A. Fleming on "Long-distance Telegraphy and Telephony."

Professor A. J. Carlson, of the University of Chicago, lectured in Toronto before the Academy of Medicine, on October 3, on "Some Recent Studies of the Physiology and Pathology of the Stomach."

A statue of Robert Koch was recently unveiled at Berlin, six years after his death.

Virgil Gay Bogue, of New York City, widely known as a civil engineer, died on October 14, at the age of seventy years.

The thirty-fourth stated meeting of the American Ornithologists' Union will be held at the Academy of Natural Sciences, in Philadelphia, November 14–16, with a business meeting of fellows and members on the 13th.

In anticipation of a possible epidemic of poliomyelitis next summer, the Illinois State Board of Health has arranged for a number of conferences on the subject at different points in the state during the winter months.

Funds have been contributed which make possible the opening of the psychopathic laboratory at the New York City police headquarters. This laboratory was opened last December in order to cull from the prisoners each day those who were mentally defective and to send them to suitable institutions. The list of those subscribing to the support of this laboratory include Andrew Carnegie, F. W. Vanderbilt, Daniel Guggenheim, Mortimer L. Schiff, William Rockefeller and Mrs. George B. Alexander.

Director W. T. Hornaday, of the New York Zoological Park, announces that the fund to

erect a building to house the Zoological Society's national collection of heads and horns had been raised. The building will be built in 1917 and opened to the public in the spring of 1918. The fund is made up of ten subscriptions of $10,000 each, the donors being Mrs. Frederick Ferris Thompson, Mrs. Russell Sage, John D. Archbold, Jacob H. Schiff, George F. Baker, Mrs. Louise W. Carnegie, Andrew Carnegie, Edmund C. Converse, Samuel Thorne, and two others who signed themselves, respectively, "In Memoriam" and "A Friend."

THE *Journal* of the American Medical Association notes that the *Therapeutische Monatshefte* for September arrived on October 8, the first German medical journal to reach its office since early last May. Before the war twenty-six German journals were indexed regularly. The German medical journals are being published regularly, as abstracts from them appear in the Scandinavian and Netherlands exchanges.

THE celebration on June 13 in connection with the centenary of the Botanic Gardens, Sydney, are noted in *Nature*. Speeches were delivered on the occasion by the governor of New South Wales, the premier, and the minister for agriculture, and a brief historical address was given by Mr. J. H. Maiden, F.R.S., the director of the gardens. Three vistas were named, respectively, after Capt. Cook, Sir Joseph Banks and Governor Phillip, and a rosery is to be known in future as the "Centenary Rosery." The following memorial trees were planted simultaneously by representatives of the Empire and the Allies: Great Britain and Ireland, the British Oak (*Quercus pedunculata*); Australia, the Bunya Bunya (*Araucaria Bidwilli*) and the Flame Tree (*Brachychiton acerifolia*); Sydney, the Port Jackson Fig (*Ficus rubiginosa*); New Zealand, the Kauri (*Agathis australis*); South Africa, the Cape Chestnut (*Calodendron capensis*); Canada, the Sweet Gum (*Liquidambar stryraciflua*); India, Indian Date Palm (*Phoenix sylvestris*); Belgium, Black Belgian Poplar (*Populus monilifera*); France, Nettle Tree, or Perpignan Wood (*Celtis australis*); Russia, the Aspen (*Populus tremula*); Italy, Lombardy Poplar (*Populus nigra*, var. *pyramidalis*); Serbia, the Carob (*Ceratonia siliqua*); Montenegro, the Olive (*Olea europæa*); Portugal, Portugal Laurel (*Prunus lusitanicus*); Japan, Japanese Maple (*Acer japonica*). A memorial stone of a proposed museum of botany and horticulture was laid.

THE National Forest Reservation Commission has approved the purchase by the government of 59 tracts of land with a total of 66,880 acres in the Appalachian and White Mountains. Of this, 36,000 acres is in the so-called "Kilkenny Purchase Area" in New Hampshire. It is the policy of the commission to build up government holdings, as nearly solid as may be, through buying only in certain specified places, which are designated purchase areas. The Kilkenny Purchase Area adjoins the so-called "White Mountain Purchase Area" on the north, and is on the watershed of the Connecticut River. The land now approved for purchase is the first to be acquired in the Kilkenny Area. About 17,000 acres of land on the White Mountain area was approved. This land lies for the most part on the west slope of the Carter Range and practically completes the government purchases in the northern portion of the White Mountain region. With this land a total of 698,086 acres in the White Mountains has been acquired. Smaller tracts were purchased in the southern Appalachian Mountains, the largest total on any area being that of 7,678 acres in Transylvania County, North Carolina, on the Pisgah Forest. Other tracts in Avery, Caldwell, Macon and McDowell Counties, North Carolina, on the Boone, Nantahala and Mt. Mitchell areas, aggregate 1,870 acres. Approximately 2,000 acres of the approved lands are on the Potomac, Shenandoah and Natural Bridge areas in Virginia; 956 acres are in Rabun and Union Counties, Georgia, and the remaining 586 acres are in Monroe and Sullivan Counties, Tennessee. Congress recently reappropriated the $3,000,000 of the original fund which was not spent in the beginning of the work and which consequently reverted to the treasury. This money, accord-

ing to the officials in charge, will be used mostly to round out the lands already acquired, so that they may be easily and economically administered. In making future purchases it is stated that the policy will be to select those tracts which block in with lands already purchased and which are offered at the most reasonable prices. The acquisition of lands was begun in 1911 under the so-called "Weeks Law," which permitted the government to purchase, for national forest purposes, lands on the headwaters of navigable streams in the White Mountain and Appalachian regions. To date 1,396,367 acres have been approved for purchase.

THERE has recently been organized, with headquarters at Minneapolis, The American Association for the Promotion of Technical Education in India. The purpose of the society is to promote the development of the American type of education in agriculture and the mechanic arts in India, by assisting Hindoo students who are in attendance at American universities and colleges in selecting their own educational training while here and in planning for service in industrial education upon their return to India. Local sections of the society have been organized at Pullman, Washington, and at Minneapolis, Minnesota; and others are in process of organization at other state institutions. R. W. Thatcher, assistant director of the Minnesota Agricultural Experiment Station, is acting-president of the association, and V. R. Kokatnur, a graduate assistant in the school of chemistry of the University of Minnesota, is general secretary. It is hoped that through the work of this association, the efficiency-ideal of American technical education may be introduced into India, and may serve to assist the Indian people in developing and utilizing their industrial resources, and so tend to prevent the frequent recurrence of the terrible famines of the past.

THE *Journal* of the American Medical Association states that the Henry S. Wellcome prizes, offered through the Association of Military Surgeons, viz., first prize, a gold medal and $300, and second prize, a silver medal and $200, are open for competition to all present and former medical officers of the army, navy, Public Health Service, Organized Militia, U. S. Volunteers, Medical Reserve Corps of the army, navy and of the officers reserve corps of the U. S. Army. These prizes will not be awarded until after December 15, 1916, the council of the association having voted to extend the time of entry of competing essays to that date, because so large a number of the members are now with the troops on the border. Several essays have already been received and a large additional number are expected to be entered for such honorable and valuable prizes. The subject for the first prize is "The Most Practicable Plan for the Organization, Training and Utilization of the Medical Officers of the Medical Reserve Corps, U. S. Army and Navy and of the Medical Officers of the Officers' Reserve Corps, U. S. Army, in Peace and War." The subject of the second prize is "The Influence of the European War on the Transmission of the Infections of Diseases, with special reference to its Effect on Disease Conditions of the United States." Essays (five copies signed by nom de plume) not to exceed 20,000 words, exclusive of tables, must be addressed to the secretary of the Association of Military Surgeons, U. S. Army Medical Museum, Washington, D. C.

THE Oberlin Geologic Survey spent the period from June 15 to August 3 in Southern Vermont, near the village of Wilmington. Two groups of students were organized, one for physiography and geographic work, the other for geologic work. The field chosen had been mapped by the topographers of the United States Geologic Survey, but no geologic or topographic map had been made. The rocks were found to be almost entirely metamorphic systems indurated here and there with dikes of basalt quartz and granite. No mineral deposits were found worth working-up, and great quantities of magnetite and tourmaline, and garnet in disseminated crystals were found. The rocks were mostly originally

estuarian sands, clays and calcareous beds. Dr. Hubbard devoted the remainder of the summer to working for the Ohio Geologic Survey, part of the time in the field and part of the time writing. The preparation of the *Bulletin* for the State Survey, in the physiography of the state of Ohio, is well advanced. It is hoped that the manuscript may be ready for the printer by next year.

Nature states that before the war Russian men of science, and especially biologists, had to send a very considerable proportion of their writings abroad for publication, and the German journals thus became the common medium for much of the best Russian work. Soon after the outbreak of war efforts were made to remedy this state of affairs; of the new journals, Professors Shimkewitch and Dogiel are editing the *Russian Journal of Zoology*, Professors Sewertzoff and Elpatiewsky the *Revue Zoologique Russe*, and Professor Dogiel the *Archives Russes d'Anatomie, d'Histologie et d'Embryologie*. The first number of the latter has just appeared. In spite of the enormous drain on Russian finances, the minister of public instruction made the publication of this journal possible by a government subsidy.

UNIVERSITY AND EDUCATIONAL NEWS

A GIFT of $60,000 for an observatory and 36-inch telescope has been given to the University of Arizona by a donor whose name is withheld.

THE University of Pennsylvania has received $25,000 from the estate of Anna Yarnall, the income of which is to be used for the maintenance of the Botanic Gardens of the university.

ROBERT W. KELLY, of New York, of the class of '74, has given $125,000 to the Yale Alumni Fund.

THE new ceramic engineering building of the University of Illinois is to be formally dedicated on November 20 and 21. It is expected that the exercises will be attended by many representatives of the architectural, structural, mining, geological, chemical and manufacturing interests. In connection with the dedication exercises an industrial conference will be held, in which a number of topics of current interest to the ceramic engineer, the clay-worker and the manufacturer will be discussed by well-known experts. The ceramics building is a fireproof structure three stories high and with basement.

THE salaries of all full professors at Brown University has been increased by $400. The minimum salary is now $3,000 and the maximum salary, except for administrative officers, is $3,650.

DR. ARTHUR R. EDWARDS has resigned as dean of Northwestern University Medical School. Arthur I. Kendall, professor of bacteriology, has been made acting dean.

DR. OTTO DUNKEL, of the University of Missouri, has been appointed assistant professor of mathematics at Washington University, St. Louis.

PROFESSOR WILLIAM H. KAVANAUGH, who has been a member of the engineering staff of the University of Minnesota for fifteen years, has resigned his position as professor of experimental engineering to accept a professorship in the Towne Scientific School of the University of Pennsylvania.

RALPH PATTERSON ROYCE, formerly livestock editor of the *Missouri Farmer*, has been appointed instructor in animal husbandry at the University of California Farm.

THE following appointments have been made in the laboratories of the University of Nebraska, College of Medicine, Omaha: H. E. Eggers, B.Sc., M.A. (Wisconsin), M.D. (Rush), professor of pathology and bacteriology; John T. Myers, A.B. (Washburn), M.S. (Kansas), instructor in bacteriology; Amos W. Peters, A.M., Ph.D. (Harvard), assistant professor of bio-chmemistry.

DR. ARDREY W. DOWNS, formerly professor of physiology at the Medico-Chirurgical College, Philadelphia, has accepted the chair of physiology at McGill University, Montreal.

PROFESSOR H. HAHN, of Czernowitz, has been appointed professor of mathematics at Bonn.

DISCUSSION AND CORRESPONDENCE

THE CENSUS OF FUR SEALS, 1914 AND 1915

INTEREST in the fur seals of the Pribilof Islands at the present time centers largely in the annual enumeration of the animals. Since 1912 a complete count of the pups born has been made each season, which constitutes an exact enumeration of the breeding females. In 1911 pelagic sealing, which had occasioned the herd's decline, was suspended by international treaty. The count of pups was instituted to secure an exact figure for the breeding stock at its lowest point and was continued to secure a measure of its annual increase.

Comparison of the figures for 1912 and 1913 showed a gain of 12½ per cent. This was approximately what was expected from the experience of many years in taking the annual quota of young male seals. Unfortunately the count of 1914 was made by men not previously experienced in the work and a new set of personal equations was introduced. The result gave a gain of only one per cent., without any adequate explanation for the irregularity. The results of the count for 1915, made by the resident agents on the islands, are now available, and, while they are affected by another new set of personal equations, this time an experienced one, a practically normal condition is found to exist; a gain of 11 per cent. in pups is shown over the count of 1914.

In the December issues of SCIENCE for 1912 and 1913 the censuses for these seasons were published. The census for 1914 appears at page 39 of Senate Document No. 980, the report of the investigating committee of 1914. The census of 1915 has not as yet been published. The figures of these two seasons may be contrasted with those for 1913 as follows:

Animals	1913	1914	1915
Breeding bulls[1]	1,403	1,559	2,151
Breeding cows[1]	92,269	93,250	103,527
Idle bulls[1]	105	172	673
Young bulls[1]	259	1,658	11,271
4-year-old bachelors[2]	2,000	9,939	15.848
3-year-old bachelors[2]	10,000	13,880	18,282
2-year-old bachelors[2]	15,000	17,422	23,990
Yearling bachelors[2]	20,000	23,068	30,307
2-year-old females[2]	15,000	17,422	23,990
Yearling females[2]	20,000	23,067	30,306
Pups of the year[1]	92,269	93,250	103,527
Totals	268,305	294,687	363,872

No particular importance attaches to the final totals or to the estimated groups in this table. The non-breeding animals can not all be seen together at any one time nor counted in any way. The estimates are based on assumptions regarding the mortality suffered by the different classes of animals on the winter migrations, and these assumptions are slightly different for each census. The important elements are the counted items, giving the three essential factors in the herd—the breeding females, the breeding males, and the reserve of male life—the idle and young bulls growing up.

Two facts of great importance are established by these counts. The first is that the herd has made a substantial growth in the years since pelagic sealing was abolished. The stock of breeding females which in 1912 numbered 82,000 now numbers 103,000. The suspension of pelagic sealing, accomplished by the treaty of 1911, has, therefore been effective in staying the decline and in restoring the herd to a condition of normal growth.

The second fact is that there has been an abnormal increase in the stock of reserve males. In 1913 this reserve was represented by 364 animals for an active stock of 1,403—an adequate reserve, since the breeding life of the male is six to eight years. In 1914, however, this reserve had advanced to 1,830 animals, more than equaling the active stock of 1,559. In 1915 it had advanced to 11,944 for an active stock of 2,151, giving a reserve of five times the active stock. The season of 1916 having now passed, the 15,848 four-year-old bachelors of 1915 have taken their places in this reserve, bringing it up to a total of about 27,000 animals, approximately ten times what the active stock should be. To this again will be added the 18,282 three-year-old bachelors of 1915, as reserve bulls of five years and over, in 1917. In that season the law which is occasioning this abnormal condition will have

[1] Actual counts.

[2] Estimates.

passed its first stage of complete suspension of killing, but it will go on for nine further years adding 4,000 unnecessary reserve bulls annually.

The harmful effect of this abnormal state of affairs is already beginning to be evident. Preliminary information regarding the conditions found in 1916 show a total of 3,500 harems on the Pribilof Island rookeries. In other words, while there has been a gain of about 25 per cent. in the stock of breeding females since 1912, there has been a gain of about 150 per cent. in breeding males. This is due to the pressure of idle bulls upon the breeding herd. The increase in this class of animals since 1912 is 2,280 per cent. These animals crowd into the massed rookery portions and establish small harems by capture, and their attempts to hold and augment these harems keep the breeding grounds in a constant turmoil to the injury of the mother seals and the trampling of their young. This condition will grow steadily worse as the young males now being released from killing grow to maturity.

More important still is the obscurity which this increasingly abnormal condition will throw over the vital facts of the herd—its normal rate of increase and the proper proportion of male life—which a prolongation of the normal condition of the last six or eight years, throughout the early stages of the herd's recuperation, would have cleared up. On this subject I may quote the following paragraph from my report to the Bureau of Fisheries in 1913:

> Unfortunately, if the suspension of land killing is prolonged, the balance will be broken. The herd will begin at once to enter upon a new era of abnormal conditions (like those of 1896–97). The pressure of the idle bulls will increase the number of harems without reference to increase in cows and the averages (resulting from the counts of pups) will become useless. The mortality among the cows and pups will increase frightfully, retarding the development of the herd. The work of rookery inspection and investigation will be rendered difficult and dangerous. The handling of the bachelor seals on the killing fields will also be attended with difficulty and danger by reason of the bulls which will necessarily be taken up in driving. Hauling grounds and breeding grounds will be overrun by a horde of savage, fighting bulls. The herd will go into eclipse and it will be fifteen or twenty years before it emerges from the darkness and begins to show normal conditions again. Its size will then preclude the possibility of counts or accurate estimates to enable those in charge to find a basis of understanding the herd such as we have to-day.

The condition thus warned against is now practically inevitable. The department of commerce, by accepting as "wise and sound legislation" the fur-seal law of 1912 and taking no step towards its repeal or amendment, has deliberately thrown away the opportunity to settle the two important facts vital to the future administration of the fur-seal herd.

GEORGE ARCHIBALD CLARK
STANFORD UNIVERSITY, CALIF.,
September 19, 1916

IS DYNAMICS A PHYSICAL SCIENCE?

PROFESSOR HUNTINGTON'S latest communication[1] helps to make clear the difference between his method of treating mass and the usual treatment. According to the ordinary view, such problems as the one proposed by me are solved very simply by the principle that *the mass of a body is the sum of the masses of its parts.* Although Professor Huntington does not give a general[2] solution, he indicates that his method also makes use of this principle of additivity, but only after it has been *proved* by an analysis involving internal forces, the law of action and reaction and the law of vector composition of forces. Apparently he is unwilling to assume as fundamental even the fact that the mass of a body is increased by adding matter to it. I have no logical objection to this procedure, but it seems to me to be an unnecessarily difficult method of introducing a very simple principle. It is to be noted, moreover, that the proof of

[1] SCIENCE, September 8, 1916.

[2] The general solution must cover any case whatever in which a body is formed by putting together the material of two bodies; for example, the case of a body formed by fusing together two lumps of metal.

the theorem employed by Professor Huntington involves a physical principle not explicitly stated by him, namely that *matter consists of individual particles, each of which preserves its identity and its mass throughout all physical or chemical changes.*

Those who believe that mechanics should be regarded as a physical science rather than a branch of pure mathematics will probably agree that in elementary instruction it is less important to build up a logical framework than to help the beginner to appreciate the physical meaning of dynamical laws.

L. M. Hoskins

Stanford University,
September 16, 1916

FLASHING OF FIREFLIES

To the Editor of Science: The notes by Mr. Edward S. Morse in Science for February 4 and September 15, 1916, on fireflies flashing in unison, have been of very great interest to the writer, in connection with his studies of the light-emission of American Lampyridæ,[1] and during the course of these observations he has constantly been on the watch for synchronous flashing of the type reported by Mr. Blair and by Mr. Morse. There seems to be no doubt that it is a fairly frequent, if not a constant, method of light-emission among certain tropical (mainly oriental) Lampyrids, but instances of it in our North American species must be fortuitous, at least in this locality. The writer's observations so far made have been on *Pyractomena borealis, P. lucifera, P. angulata, Photinus pyralis, P. consanguineus, P. scintillans, P. marginellus, P. castus* and *Photuris pennsylvanica.* In most of these there is now no doubt that the photogenic function serves as an attraction between the sexes for mating, and synchronous flashing of a large number of individuals would seem to be of such a nature as to interfere with this function of the light. Among the species studied, there would appear to be a possibility of anything approaching synchronous flashing only in *Photuris pennsylvania,* whose lighting habits it has been found difficult to follow accurately. On one or two occasions during the past summer observations were made by Mr. H. S. Barber, of the National Museum, and the writer, of what appeared to be the alternate illumination of adjacent trees in which this species was present in abundance, but it was soon evident that while at a given instant one tree may have been more highly illuminated than the other, there was nothing approaching periodicity in the phenomenon, and no continuation of it was noticed. Of course, special conditions of temperature, moisture, air currents, etc., might influence these insects in such a way as to produce synchronous flashing, but although especially watched for, we have been unable to secure an observation of it. If any other observations of this character have been made on North American species of Lampyrids, the writer would be very glad to hear of them.

In regard to the synchronous head movements of ants, referred to by Mr. Morse as having been reported by Cox, it may be noted that one of our common web-worms exhibits a very similar conduct, a stimulus, such as a shadow passing over the colony, being sufficient to cause all of the caterpillars to jerk the head and forward segments from side to side, the great majority of them to the same side at the same time.

F. Alex. McDermott

Washington, D. C.,
September 20, 1916

[1] *Canadian Entomologist,* 1910, Vol. 42, p. 357; 1911, Vol. 43, p. 399; 1912, Vol. 44, pp. 73, 309; *Zeitschrift fuer wissenschaftliche Insektenbiologie,* 1914, Vol. 10, p. 303.

OCCURRENCE OF YELLOW LEAF RUST OF WHEAT (PUCCINIA GLUMARUM) IN THE SALT LAKE VALLEY, UTAH

On June 23, 1915, the writer and one of his assistants, Mr. W. W. Jones, collected an apparently new rust on wheat in several fields north and west of Ogden, Utah. It was noted that the infection was very serious and in some instances the fields had the appearance of suffering greatly from drouth. A careful examination, however, showed that this condi-

tion was due to the rust, the uredo stage of which was just beginning to make its appearance. The specimens were put away and were not again examined until a short time ago when it was decided to make a proper identification of them. When they were taken it was our intention to revisit the fields and collect the teleuto stage, but owing to press of other work this was not done. When a reexamination of the material was made we found it impossible to determine the species and a sending was therefore made to Mrs. Flora W. Patterson, mycologist, U. S. Department of Agriculture, Washington, D. C. The tentative opinion of the writer, that the rust in question was none other than *Puccinia glumarum* Eriks. and Henn., has been confirmed both by Mrs. Patterson and the pathologists in the Cerealist's Office at Washington.

Just two days previous to our finding this rust, Dr. F. Kolpin Ravn, of Copenhagen, Denmark, Mr. A. G. Johnson, of the University of Wisconsin, and Dr. H. B. Humphrey, of the U. S. Department of Agriculture, visited the Salt Lake Valley and were undoubtedly on the lookout for this rust which was seen for the first time in this country at Sacaton, Arizona.[1] The writer had the pleasure of entertaining these gentlemen during this visit, making with them a short automobile tour about the valley in the interest of cereal diseases.

The rust infection due to *Puccinia glumarum*, as noted in the Salt Lake Valley, is undoubtedly of greater economic importance than had hitherto been supposed. It is not known to what extent the wheat crop was injured, but it is the writer's opinion that the loss over a considerable area must have been quite heavy if the extent of the infection could be taken as a criterion. During the present season careful notes will be made on the occurrence, distribution and effect of this rust on wheat in the Salt Lake Valley and adjacent districts.

P. J. O'Gara

Dept. of Agri. Investigations,
American Smelting and Refining Co.,
Salt Lake City, Utah,
June 10, 1916

[1] Science, N. S., Vol. XLII., No. 1071, p. 58.

IS INHERITANCE MODIFIED BY ACQUIRED CHARACTERS?

In the *American Naturalist* for August, 1916, I find an interesting article by Dr. C. B. Davenport, on "The Form of Evolutionary Theory that Research Seems to Favor." The general result of his investigation is "that the course of evolution is chiefly determined by internal changes," that is, by genetic changes. He, however, reminds us that "there is some evidence . . . that the germ plasm is not beyond the reach of modifying agents. At least we must continue experimental efforts in that direction."

The question which I wish to raise is whether attention has been given to the book by Walter Kidd, entitled "The Direction of Hair in Animals and Man," published by Adam and Charles Black, London, 1903. On pages 76 and 81 will be found pictures showing the difference in the arrangement of hair on the head of the chimpanzee, and that found on the heads of many young human subjects, who seem to have inherited some of the new arrangements through the influence of the artificial parting of the hair, practised by their ancestors for several generations. If these pictures correctly represent inherited conditions, it seems impossible to attribute them to spontaneous variations, uninfluenced by habit, and preserved simply because they gave their subjects superior power in the struggle for life, or because of any other form of selection.

For several years failing eyesight has restricted, not only my own investigations, but my knowledge of what others have accomplished; and I shall be thankful for any information as to whether these points have been discussed in the *American Naturalist*, or in any of our scientific journals.

John T. Gulick

Honolulu, T. H.

TUMORS IN PLANTS

At last I have succeeded in producing small tumors in plants without the use of the crown gall organism (*Bacterium tumefaciens*), *i. e.*, simply by means of substances which are by-

products of the bacterial growth. The tumors though small have been obtained repeatedly on several kinds of plants and there seems to be no reasonable doubt that they are due to the fleeting chemical stimulus which I have applied. Judging from my experiments, which have been continued for some months, the mechanism of tumor growth appears to be wholly one of changed osmotic pressures brought about by the metabolism of the tumor parasite. A full paper will be published as soon as I have finished studying my serial sections and have had time to make suitable photomicrographs to illustrate it.

ERWIN F. SMITH
U. S. DEPARTMENT OF AGRICULTURE,
WASHINGTON, D. C.,
October 17, 1916

QUOTATIONS

THE OPTICAL INDUSTRY IN FRANCE

A SERIES of articles by various authors has recently been appearing in the *Revue générale des Sciences* on the methods to be adopted for the development of French trade after the war. Amongst these have appeared two articles (May 30 and June 13) by M. A. Boutaric on the French optical industry and its future.

He points out that before the Napoleonic wars France had been dependent on England for its optical glass, and it was as a result of the British blockade that its manufacture was commenced in France.

At the present time the house of Parra-Mantois manufactures practically all the special optical glasses made by Schott and Co., and the French makers undoubtedly are more successful than their competitors in the manufacture of the glass discs required for very large astronomical mirrors and objectives. In every branch of optical science French physicists have invented instruments and methods for testing their qualities, but the French manufacturers have not done themselves justice by an efficient catalogue propaganda. M. Boutaric, when referring to the firm of Zeiss, mentions especially that it "has surrounded its products with a scientific propaganda." He shows how severe the German competition in microscopes was before the war, although there are two good French makers—Nachet and Stiassnie. The metallurgical microscope of Le Chatelier has been developed by Pellin with considerable success. The polarimeter in its present commercial form was developed by the French makers Soliel and Laurent, and is essentially a French instrument, yet the German houses have almost obtained a monopoly in the sale of the instrument outside France.

The manufacture of binoculars is the most successful of all the French optical industries, several large firms (Balbreck, Baille-Lemaire, Société française d'Optique, Société des Lunetiers, etc.) being employed in their manufacture. As showing the large quantity of optical glass used in these glasses, it is stated that the Société des Lunetiers alone use about 200,000 kilos of glass annually.

Although French makers showed several prism binoculars of the Porro type at the 1867 Exhibition, yet the manufacture of these glasses passed almost entirely to Germany. Now, however, glasses equal to the best German models are being made in France in large numbers for her army and those of her Allies. The original supremacy of the French photographic lens has passed away, because, in the opinion of M. Boutaric, the French makers did not use the new glasses and modern grinding methods, nor sufficiently avail themselves of skilled technical knowledge. M. J. Richard has developed with great skill and success a stereoscopic camera, the "Verascope," and also a very rapid camera shutter, but the majority of the cameras used in France have been imported. The kinematograph, the invention of a Frenchman, Professor Marey, has been carried to a high state of perfection by the firms of Lemaire, Pathé and Gaumont. To a certain extent France is dependent on outside sources for kinematograph film, but, on the other hand, she exports finished printed film to the annual value of £600,000. The lighthouse industry, built on the theoretical work of Fresnel, is a successful one, although it has had to face keen competition from English and German makers.

M. Boutaric points out that although in nearly all optical matters French savants are the pioneers, yet the French optical industry is very small as compared with the German. In an interesting paragraph he endeavors to analyze the reasons for this success. "Here, as in everything else, the Germans have been saved by their deep sense of business. The German industry demonstrates by a wise publicity the worth of its goods, sometimes excellent, but sometimes also copies of our models and inferior to ours; their catalogues, well edited and illustrated, are published in many languages, and give full details of the instruments they describe, their travelers, men of parts, knowing intimately their instruments . . . and trying to satisfy the wishes of their customers."

M. Boutaric points out that the collaboration between the man of science and the manufacturer is far more close in Germany than in France. In the former the man of science is in intimate touch with the works, and is well paid for his services. The foreman and apprentices are trained in the theoretical side of their subject in classes they are obliged to attend. In the firm of Zeiss half the time spent by the workers in the technical classes is counted as time spent in the works. No steps are neglected to perfect the organization as a whole; everything is done to make the machine independent of a single individual. In France the success and reputation of a firm have too frequently depended on one individual. That some steps are being taken to strengthen the optical industry in France is shown by the fact that a large factory has been built by La Société française d'Optique, formed in conjunction with the firm of Lacour-Berthiot, for meeting the competition of the best German firms. M. Boutaric urges that if the future of the industry is to be assured, new blood must be introduced, young mechanics trained, and a school of optics founded. This school, for which M. Violle has pleaded, should be divided into at least two sections: optics proper and photography. In it practical classes on glass grinding, etc., should be given in conjunction with theoretical work.—*Nature.*

SCIENTIFIC BOOKS

A System of Physical Chemistry. By W. C. McC. Lewis. New York: Longmans, Green, and Co., 1915. 19 × 13 cm.; 2 vols. Pp. vii + 552; xiv + 523. Price $2.50 net, each volume.

In the preface the author says: "The scientific treatment of any set of phenomena consists in applying the minimum of general principles or theories which can afford a reasonable explanation of the behavior of matter under given conditions; and predict its behavior under new conditions. The principles referred to as far as physics and chemistry are concerned are the kinetic theory and thermodynamics. In the kinetic method of treatment emphasis is laid upon the actual molecular mechanism of a given process; in the thermodynamic method the emphasis is laid upon the energy changes involved. Both methods should be familiar to any one who undertakes the task of original investigation. . . . I have therefore divided the book into three parts, in which the phenomena exhibited by systems in equilibrium and not in equilibrium are treated first from the 'classical' kinetic standpoint only; then independently from the thermodynamic; and finally from the standpoint of thermodynamics and the new or 'modified' principles of statistical mechanics."

One obvious criticism of this plan is that the same subject is treated more than once, which seems a pity. The author has covered an enormous amount of ground. He takes up electrochemistry pretty thoroughly; he has one chapter on colloid chemistry, another on Nernst's heat theorem; a third on photochemistry, and a fourth on the quantum theory. In a sense it is therefore a pretty comprehensive treatise on physical chemistry, covering something the same ground as Nernst's "Theoretical Chemistry" but in more detail. The plan of the book is an ambitious one; but the task was rather more than the author could handle. The treatment is essentially not critical and the reviewer finds the book much less interesting and inspiring than Mellor's "Chemical Statics and Dynamics."

Wilder D. Bancroft

ON THE ETIOLOGY OF EPIDEMIC POLIOMYELITIS[1]

By the combined use of methods employed by Rosenow in a bacteriologic study of various diseases including diseases of the nervous system and the methods of Flexner and Noguchi in their study of poliomyelitis, we have isolated from all of 52 cases of poliomyelitis a peculiar streptococcus. This organism has been obtained from the throats, tonsils, abscesses in tonsils and from the central nervous system. It has been obtained from the ventricular fluid after death, but not from the spinal fluid during life. In only one instance has it been isolated from the blood during life.

In seventeen fatal cases the tonsils showed from one to fifteen abscesses. These were situated near the capsule and contained a peculiar gelatinous opalescent material from which this peculiar streptococcus was isolated in large numbers.

The microorganism is remarkably polymorphous, appearing to grow large or small according to the medium on which it is grown. Details as to its growth on various media may be found in the *Journal* of the American Medical Association for October 21, 1916. In general, it may be said that under aerobic cultivation and in dextrose-containing media, the organism tends to grow large, while in ascites fluid in tall tubes containing tissue, the small forms predominate. The latter appear to be identical with the microorganism described and cultivated by Flexner and Noguchi.

Cultures of Berkfeld N filtrates of emulsions of brain and cord of rabbits which died of paralysis after intravenous injections of suspensions of broth cultures showing only the large forms have repeatedly grown out in suitable media. The microorganism has been grown also from the filtrates of cultures showing the small form but not from filtrates of cultures showing only the large form. It has been isolated from the brain and cord of paralyzed monkeys following intracerebral injection of fresh human virus and glycerinated human and monkey virus.

The large form of the organism, injected intravenously or intracerebrally, has produced paralysis consistently in animals (rabbits, guinea-pigs, dogs, cats) which are known to be quite insusceptible to inoculations by the methods which infect monkeys—injection of emulsions of brain and cord from patients with poliomyelitis. After producing paralysis consecutively in three rabbits one strain caused characteristic paralysis and lesions of poliomyelitis in monkeys.

The cords of paralyzed animals have shown lesions very similar to those of experimental poliomyelitis in monkeys: hemorrhages and round-cell infiltration in the gray matter, as well as degeneration of the ganglion cells and neurophagocytosis.

Lesions, other than those in the central nervous system, were relatively few, but when present were most commonly found in lymph glands, the spleen, lymphoid structures in the intestinal tract, particularly in the colon and in the splanchnic region. Pure cultures of the organism have been obtained from the central nervous system in numerous animals when blood and other tissues were sterile.

It appears that the small filterable organism of Flexner and Noguchi which has been generally accepted as the cause of poliomyelitis is probably the form which this streptococcus takes in the central nervous system and in suitable culture media under anaerobic conditions, while the larger, more virulent and more typically streptococcic form which other investigators have considered contaminations is the same organism grown larger on suitable media. The larger forms may play an important part in the epidemiology of poliomyelitis.

E. C. Rosenow,
The Mayo Foundation, Rochester, Minn.,
E. B. Towne,
Peter Bent Brigham Hospital, Boston, Mass.,
G. W. Wheeler
New York Hospital, New York

[1] From the laboratories of the Mayo Foundation and the New York Hospital. Presented before the Minnesota State Medical Association, Minneapolis, October 13, 1916.

HUMAN REMAINS FROM THE PLEISTOCENE OF FLORIDA

In a paper recently issued the writer has given an account of the occurrence at Vero on the Atlantic coast in central-eastern Florida, of fossil human remains in association with extinct vertebrates.[1] Human remains have been found at this locality in two separate strata which differ in age, the one being superimposed upon the other. The older of these two beds is unmistakably of Pleistocene age, and it is from this bed that the new material now to be described has been obtained. By this new evidence, as well as by that previously given, it is definitely established that man was present in America in association with a Pleistocene vertebrate fauna. Of the mammalian species of this fauna a few, including chiefly small inconspicuous animals, have persisted to the present time, while the larger animals, including the elephant, mastodon, camel, horse, bison, tapir and sloth have suffered extinction. With the exception of bison, which are native to North America, and horses which have been reintroduced from Europe and canids which are common to the old and the new world, the nearest existing relatives of these extinct species are now found in Central and South America, in Asia or in Africa.

The vertebrate fossils at Vero are found chiefly in an old stream bed and were discovered as a result of the construction of a drainage canal which extends from the coast some miles inland. The canal was made in 1913 and a number of vertebrate fossils, which had been thrown out by the dredge while excavating through the stream valley, were obtained at that time. Human bones, however, were not found until two years later, October, 1915, the first bones obtained having been exposed as the result of the lateral caving of the canal bank. A second discovery of human remains was made in April, 1916, and a third in June, 1916. The present paper relates to the latest of these discoveries, the earlier finds having been described in the publication to which reference has been made.

[1] *Amer. Jour. Sci.* (4), XLII., pp. 1–18, July, 1916.

At the time of the discovery of the vertebrate fossils at Vero, the writer suggested to those who were collecting there the importance of keeping a close watch for associated human remains. The subsequent discoveries are to be credited very largely to the patience and persistence of Messrs. Frank Ayers and Isaac M. Weills, to whose careful observations at this locality during the past three years are due chiefly the important results that have been obtained.

A section through the stream bed at Vero is indicated in the accompanying text-figure. Number 1 of the section represents a marine shell marl which underlies a large area in eastern and southern Florida and is known from its invertebrate fauna to be of Pleistocene age.[2] Number 2 of the section consists of cross-bedded sand which at the top grades into a fresh-water marl, the whole stratum having an average thickness of from three to five feet. Vertebrate and fresh-water invertebrate fossils occur throughout this bed from the cross-bedded sands at the base to the marl rock at the top. The sand includes also partially decayed wood, and in places muck and plant fragments. It is from this bed that the human and other vertebrate fossils here described, as well as a part of those previously described, were taken. Number 3 of the section represents an alluvial deposit consisting largely of loose sand and muck which in places grades into a fresh-water marl. The average thickness of this later bed is about two feet, although in places it reaches a maximum of five or six feet.

Between the marine marl, number 1 of the section, and the sand and marl stratum holding human and other vertebrate fossils, number 2 of the section, there exists no persistent well-marked break in deposition. There is, however, a change from marine to fresh-water conditions, and accompanying this change one

[2] To this extensive deposit of marine shell marl bordering the Atlantic coast, the writer in 1912 applied the term Anastasia formation, this name having been selected because of the fact that the shell marl was first quarried and described on Anastasia Island near St. Augustine, where it is known as "Coquina." (Fla. Geol. Surv. Fourth Annual Report, p. 18, 1912.)

finds evidence of stream action, materials from the land having been washed in and deposited in channels in the marine shell marl. On the other hand, there are places in the section where the sand and shell beds of the marine deposits dove-tail into the succeeding fresh-water deposits in such a way as to indicate continuous deposition. It is probable that the fresh-water deposit indicated by number 2 of this section, represents at this locality the closing phase of the marine marl formation, the change to fresh-water conditions having been brought about by a slight shifting of the strand-line.

Between this older formation and the alluvial bed which follows, number 3 of the section, there is, on the other hand, an abrupt well-marked persistent break, the top surface of the stratum represented by number 2 being extremely irregular. The alluvial bed, the initial phase of which is represented by pronounced stream action, conforms to the irregularities of the older formation. In this later bed, number 3 of the section, is found human skeletal remains, bone implements, pottery, arrow-heads and ornaments.

HUMAN REMAINS

The first skeletal remains of man found at Vero, an account of which has previously been given, were from the bone-bearing bed represented by number 2 of the section and were taken from the south bank of the canal at the locality indicated by *a* in the accompanying text-figure. The additional human bones to which the present paper relates were found in place while excavating in the south bank of the canal at the locality indicated by *b*. At the spot where the human bones were found, owing to stream-wash previous to the deposition of the overlying deposit, the fresh-water stratum, number 2 of the section, is only about 18 inches thick. The human bones were found in this sand, about 10 inches above the base. The overlying alluvial beds are stratified and as usual conform to the irregularities of the underlying formation. The human bones at this place were found and removed by the writer, in the presence and with the assistance of Isaac M. Weills and Frank Ayers. The first bone found was a right astragalus; the second bone taken in place was the right external cuneiform, which lay at the same level and about six inches from the astragalus. About twelve inches farther back in the bank was found a piece from the right pubes and a part of the left ilium including that part of the bone which shows the articular surface for the sacrum. In the same stratum and at the same locality Mr. Frank Ayers found in place a thin sharp-edged flint which evidently is a spawl from the manufacture of some kind of a flint implement. Upon sifting the sand in which these bones were imbedded there was obtained two phalanges, a section from a limb bone and some other human bone fragments. In these siftings there was found also a small flint, worked on one side, two small spawls, and a piece of a bone implement.

Vertebrate fossils in immediate association with the human bones, found in place in this stratum, number 2 of the section, include the following: *Odocoileus* sp., left scapula; *Elephas columbi*, tooth fragments; *Equus* sp., part of a tooth; *Tapirus haysii?*, part of a tooth, and *Didelphis virginiana*, part of a lower jaw. From the siftings the following additional species have been obtained: *Sylvilagus* sp., teeth and part of lower jaw; *Chlamytherium septentrionalis*, dermal plates; *Dasypus* sp., dermal plate; *Sigmodon* sp., teeth; *Neofiber alleni*, teeth; and *Cryptotis floridana*, lower jaw; as well as bones representing birds, reptiles, batrachians and fishes. Of these fossils the scapula of the deer was found within a few inches of the human astragalus and at the same level, while the other specimens were found near by, none of those listed being more than five feet from the human bones. From the same stratum, ten feet farther west, was obtained, upon passing the sand through a sieve, a small bone implement and a small flint which represents either a spawl or a very small flint tool. The vertebrate fossils found at this place include the following: *Odocoileus* sp., teeth; *Equus* sp., foot bone; *Dasypus?* sp., dermal plate; *Didelphis virginiana*, tooth; *Elephas columbi*, parts of teeth;

Chlamytherium septentrionalis, foot bone; and *Sylvilagus* sp., teeth. Among additional mammalian species known to pertain to this horizon are the following, all of which have been found in place in the canal bank in stratum number 2 of the section at Vero; *Megalonyx jeffersonii, Mammut americanum, Vulpes pennsylvanicus?, Equus leidyi, Equus complicatus, Smilodon* sp., *Procyon* sp., *Canis* sp. nov. and a peccary. Of these fossils the first three species listed were found with or near the first human skeleton obtained at Vero. Other species found at this locality and referred provisionally to this horizon include the following: *Equus littoralis, Hydrochoerus* sp., and a camel.

overlying deposits at this new locality are laminated and consist of alternating layers of sand and muck which could not have been dug through without affording evidence of having been disturbed. The possibility of the human remains representing a recent burial is thus excluded.

The conclusions that may be safely drawn from the data thus far obtained by this work in Florida may be stated as follows: Man was present in America in association with a mammalian vertebrate fauna that is universally recognized as being of Pleistocene age. With regard to culture, the men of the particular stage of the Pleistocene to which this paper relates were then making flint implements, a

Fig. 1. Section showing strata exposed in the canal bank at Vero. Horizontal scale, 1 inch equals 50 feet; vertical scale, 1 inch equals 15 feet. The break in the sketch indicates the entrance of a lateral canal. Human skeletal remains are found at *a*, at *b* and at *c* and *c'*. The human remains at *c* and *c'* lie at or very near the contact line between 2 and 3. Those at *a* and *b* lie in the stratum represented by number 2 of the section.

If the bones representing these animals were found only in fragments and lay near the base of the bed, they possibly would be under suspicion of having washed into the deposit from an older formation. The bones, however, are distributed throughout the stratum from base to top. Moreover, the next older beds at this locality are marine and contain few land fossils. Of proboscidian remains there have been found in place in this stratum complete teeth and parts of tusks so fragile that they can be removed intact only with difficulty, while of the wolf, *Canis* sp., a nearly complete and fragile skull has been secured. Fossils of this character can not possibly represent reworked material. The species known to pertain to this horizon afford conclusive evidence of the Pleistocene age of the formation.

The appearance and degree of mineralization of the human bones is the same as that of the associated fossils. In addition the fact fully established by the discovery in place in the Pleistocene bed of a spawl from such an implement. They probably were also making bone implements, two of which have been obtained from screenings from the Pleistocene deposit. They apparently also had acquired the custom or art of engraving on bone, this conclusion being supported by the discovery in place in the Pleistocene bed of bones and of a proboscidian tusk having markings which seemingly were made by tools. Further support of this fact is derived from the presence in the formation of small flints obtained from screenings which may have served as tools for this purpose.

The human remains and the associated fossils are more fully described in a report soon to be issued by the Florida State Geological Survey.

E. H. Sellards

Geological Survey,
Tallahassee, Fla.

SPECIAL ARTICLES

THE ANALYSIS OF "DUST" COLLECTED IN A VACUUM CLEANER FROM THE BOOK SHELVES OF THE RENSSELAER POLYTECHNIC INSTITUTE LIBRARY

Microscopical Examination.—Hair, green wool, white wool, cotton fibers, fly wings, sand grains, wood, paper, string, celluloid, pieces of finger nails, metallic iron and leather.

Life in water suspension of dust (microscopically × 320), none.

Qualitative examination: Iron, aluminum, sodium and calcium.

Volatile matter—39.74 per cent.

Ash—60.26 per cent.

Silica—14.18 per cent. (hydrofluoric acid test).

Total nitrogen—1.01 per cent. (Kjeldahl method).

Nitrogen as nitrates—.015 per cent. (color test).

Nitrogen as nitrites—.0001 per cent. (color test).

Chlorine as chlorides—.15 per cent. (equivalent to .2485 per cent. of common salt).

Total carbon—15.9 per cent. (by combustion furnace).

Nutrient jelly, total bacteria count (average of 6 plates)—318,000 per gram.

Lactose litmus agar, total count—9,000 per gram.

Bacillus coli communis—present (lactose bile).

Bacteria counts were secured from one gram of the dust shaken with sterile water.

THE ANALYSIS OF LIBRARY DUST

The floor of the library is of Torazzo and the book shelves are made of sheet steel painted with gray zinc paint.

The microscopical examination of the dust showed human hair and other hair probably derived from soft hats. There were likewise wool and cotton fibers from clothing, sand from the mud tracked in on shoes and the gradual pulverizing of the floor; fly wings from dead flies and paper from book leaves. The remaining articles present explain themselves. In a water suspension of this dust no life could be detected with a lens magnifying 320 diameters.

The elements found in the qualitative examination come chiefly from the wear and tear of the floor and walls; the latter being coated with plaster of Paris probably accounted for most of the calcium. Mud tracked in would account for some of the iron and aluminum present. The sodium found was due to the wear of the floor as well as perspiration from the handling of the books. Metallic iron was furnished by the nails in shoes and was removed from the dust by the use of a magnet.

The low per cent. of volatile matter, 39.74 per cent., is due to organic materials such as wool, cotton, shoe leather and rubber heels. The high ash, however, is accounted for by the compounds of iron, aluminum, calcium and silicon present as well as by the metallic iron noted above.

The total carbon content is high, but considering the amount of wool and cotton present together with paper fiber, coal dust and smoke from nearby chimneys and locomotives, this amount can be readily understood.

The chlorine is probably all present as sodium chloride (common salt) which might come, as stated above, from perspiration left on the books and mud carried in on shoes.

The total nitrogen is high, the nitrates and nitrites low, hence the nitrogen must be present almost entirely as nitrogenous organic materials such as hair and other fixed organic compounds.

The *Bacillus coli communis* was found. It may come from several sources, the most probable one being the hands while handling books. The bacillus might also be present because of the coughing, sneezing and possible expectoration of people using the library.

The total number of bacteria in the dust of such a confined space as a library would naturally be high, as the dust would catch the bacteria and have a tendency to hold them.

One of the chief points of interest connected with this analysis is the presence of *Bacillus coli communis*. Where this organism survives, more harmful bacteria might also remain, such as those producing typhoid fever, cholera, diphtheria and especially tuberculosis, which latter disease is caused by a bacillus especially able to resist the sterilizing influence of drying.

R. R. Rees

SCIENCE

FRIDAY, NOVEMBER 3, 1916

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

THE NEW PHYSIOLOGY[1]

LOOKING back on the history of physiology we can see that there have been various turning-points in general physiological theory, and consequently in the trend of research. Particular discoveries or series of discoveries, often in allied sciences, have led to these turning-points.

The last great turning-point in physiology was about the middle of last century. Up till then it was generally held that in a living organism a specific influence, the so-called "vital force," controls the more intimate and important physiological processes. Inspired by the rapid advances of physics and chemistry, the younger physiologists of that time broke away from vitalism, and maintained that all physiological change is subject to the same physical and chemical laws as in the inorganic world, so that in ultimate analysis biology is only a branch of physics and chemistry.

The subsequent progress of physiology has shown that all, without exception, of the physical and chemical hypotheses then advanced in explanation of intimate physiological processes were far too simple to explain the facts; but the general conclusion that biology is only a special application of ordinary physics and chemistry became firmly established, and is still what may be called the orthodox creed of physiologists. It may be truly said that most physiologists look upon this creed as something which has been established for all time, and that they would be inclined to regard any deviation from it as harmful

[1] A lecture delivered before the Harvey Society, New York, October 14, 1916.

scientific heresy. Nevertheless I think that we have again reached a turning-point, and that a new physiology is arising in place of the physico-chemical physiology which has held sway for so many years. I propose in this lecture to give some account of how, as it seems to me, this new physiology is shaping itself.

It is natural for us to assume that the aim of all investigations in physiology must be to ascertain the causes of physiological activity. However complex a physiological reaction may be, the conditions which determine it can be investigated experimentally; and from long experience we can be quite certain that such experimental investigation will always lead to some result, however obscure. There is, and can be, no limit to experimental investigation of causes. When, however, we examine the results obtained by experimental physiology there emerges a point in which they differ greatly from the results ordinarily obtained in the investigation of inorganic phenomena: for it is characteristic of physiological reactions that they are dependent to an extreme degree on all sorts of environing conditions. We recognize this when we speak of stimulus and response rather than of cause and effect. When the light from a star is focused on the retina there is a physiological response by night, but none by day. The response evidently depends on the existing state of excitation of the whole retina. It also depends on the normal nutrition of the retina and brain. If the blood is abnormal in composition the ordinary response is interfered with; and we are as yet only at the beginnings of knowledge with regard to the minute changes in blood composition and other conditions of environment which are sufficient to affect the response very materially.

It is the same with every physiological response. The further we investigate the more evident does it become that each physiological response depends on a vast number of conditions in the environment of the responding tissue. On superficial investigation we do not realize this: for we can often get exactly the same response, time after time, with the same stimulus. To the attainment of this result it is only necessary to see that the conditions are "normal." It is only after more thorough investigation that we find that "normal conditions" imply something which is both extremely definite and endlessly complex. We then begin to realize that the maintenance of normal conditions is from the physical and chemical standpoint a phenomenon before which our wonder can never cease.

Physiological investigation of causes seems, thus, to lead us up to a tangled maze of causal conditions. He who looks for definite "causal chains" in physiological phenomena finds in place of them a network of apparently infinite complexity. The physiologists who led the revolt of last century against vitalism did not see this network. To them it seemed that there were probably simple physical and chemical explanations of the various physical and chemical changes associated with life. The progress of experimental physiology since that time has effectually shown that this was only a dream, and physiologists are now awakening from the dream.

But we are also awakening from another dream. About the middle of last century it seemed as if, in the current conceptions of matter and energy, we had reached finality as regards the inorganic world. The chemical atom, on the one hand, and the energy associated with it, on the other, seemed to represent bed-rock reality—a reality including not merely inorganic, but also organic phenomena. Discoveries con-

nected more particularly with electrical and electro-chemical phenomena, the periodic law, and radio-activity are awakening us from this dream also. The supposed bed-rock reality of a former generation seems to be melting down before our eyes. The solvent has been the study of particular phenomena, such as those of radio-activity. The professional physicists and chemists have hitherto kept away from the serious study of life. For the most part they have regarded life as something apart: or as a complex physical and chemical phenomenon which is not likely to throw any light on the deeper problems of physics and chemistry. In this attitude I think that they have been mistaken; but in any case it is evident that we must guard against the quite unwarranted assumption that the only possibility of advance in physiology is by the direct application to life of the physical and chemical ideas which held unchallenged sway for so many years.

In this reference I should like to reply to some remarks, made partly with reference to my own writings, by my friend Professor Macallum of Toronto, in a very able and interesting presidential address to the American Society of Biological Chemistry two years ago.[2] After frankly admitting that the apparent difficulties of the mechanistic interpretation of life "put a task upon the human spirit which is apparently not imposed thereon in the theoretic explanation of any other department of science" he proceeds to argue that this is because "our knowledge of the laws that operate in matter is as yet only a very remote approximation to the whole of the lore on this subject that is possibly attainable and that will be ultimately attained." He feels, however, that this defence of the mechanistic theory is somewhat dangerous, and therefore proceeds to point out "that though we know so little of the properties and laws of matter, we know it with a degree of certainty which is not exemplified in the case of any other department of the known or the knowable, and further that the most rational method of interpreting vital phenomena is to explain the unknown in terms of the known, to trace back the causation of the obscure and mysterious to the operations of wholly natural laws and processes."

Now with this latter sentiment I am in entire agreement; but I would point out that Professor Macallum had just invoked not what he considers the known, but, on the contrary, the totally unknown properties of matter, to furnish us with a future physico-chemical explanation of life. I confess that there is in his argument a certain theological smack which strongly appeals to me as a fellow Scotchman. In the domain of "Apologetics" he would, I feel sure, make a great impression. But in the domain of Natural Science we have to examine arguments somewhat closely, and it seems to me that his admissions, which are right and unavoidable, carry him so far that his defence of the mechanistic theory of life is wholly unconvincing. One can not get round the fact that the mechanistic theory has not been a success in the past, and shows no sign of being a success in the future.

When we look broadly at biological phenomena, it is evident that they are distinguished by one universal characteristic. The structure, activity and life history of an organism tend unmistakably to maintain a normal. Accident may destroy an organism, or even a whole species, but within limits of external environment which are the wider the more highly developed the organism is, the normal life history of each individual is fulfilled.

[2] *Journal of Biological Chemistry*, XVII., p. VIII., 1914.

If, now, we consider the advance of physiological knowledge from the standpoint of the efforts which have been made, not to ascertain the causes of vital activity, but to track out its normal details, the past history of physiology takes on a new aspect. It becomes a record, not of disheartening repulse before a hopeless wire entanglement, but of continuous progress. The new physiology of which I wish to speak to-night is a physiology which deliberately and consciously pursues this line of progress, leaving on one side what one may call the "causal" physiology handed down to us from the last generation. This new physiology is in one sense not new, but very old. It is only new in the sense of consciously pursuing an aim which has nearly always been instinctively pursued by physiologists, and particularly by the great physiologist from whom this society takes its name.

Now I think that many of my hearers will at once say that such a course may be useful up to a certain point, but that it is not true science, and that therefore we can not desert the old attempts. We must, in fact, still continue our frontal attacks on the wire entanglement. To this criticism I shall endeavor to reply later. But meanwhile I should like to explain more clearly, and by means of examples, what the new physiology aims at.

Perhaps I can do this most directly by referring first to the corner of physiology which has largely occupied my own attention—the physiology of breathing.

When we count the breaths, or measure their depth, we find much irregularity, as if there were no very definite or exact regulation of the breathing. Any active occupation, such as speaking or singing, interferes in various ways with the breathing, and the impression at first produced is that the regulation of breathing is very rough. It is also commonly believed that by special training we can increase, or "improve," the ventilation of the lungs. On the other hand it has been well known for long that the breathing is more or less regulated to correspond with the consumption of oxygen and production of carbon dioxide in the body. Thus during heavy muscular exertion greatly increased breathing accompanies the greatly increased oxidation in the tissues. Another fact, well known to physiologists, is that if the lung ventilation is by artificial or voluntary means greatly increased for a short time, there follows a period of "apnea," during which natural breathing is absent. The exact cause of this apnea was till recently obscure. In 1868 Hering and Breuer showed that the inflation of the lungs in inspiration gives rise to impulses passing up the vagus nerves, and inhibiting further inspiratory impulses from the respiratory center, at the same time starting expiration. Deflation of the lungs in expiration has a converse effect. So long as the vagi are intact they are constantly playing this game of battledore and shuttlecock with the respiratory center, and Hering called this the "self-regulation" (Selbst steuerung) of breathing. The apnea following excessive ventilation of the lungs was interpreted by subsequent physiologists as the summed inhibitory effect of repeated distentions. Fredericq showed, however, that apnea is produced when the respiratory center of one animal is supplied with blood from another animal the lungs of which are excessively ventilated. This, therefore, is a true "chemical" apnea, due to over-aeration of the arterial blood, and was distinguished from "vagus" apnea. Nevertheless the correlation of the various "factors" apparently involved in the regulation of breathing remained extremely obscure.

I observed that when the air breathed is gradually and increasingly vitiated by rebreathing it, or by what is known to miners as "black damp," the breathing is also increased, but not in any simple relation to the extent of the vitiation. With a steady increase in the vitiation the breathing at first increases only a little, but as the vitiation increases further the effect on the breathing is greater and greater. Thus an increase from 4 per cent. to 5 per cent. in the percentage of CO_2 in the inspired air produces about 20 times as great an effect on the breathing as an increase to 1 per cent. from the normal of 0.03 per cent. Observations of this kind suggested that the breathing is so regulated as to maintain a certain normal percentage of carbon dioxide in the air within the lungs, and that as the percentage in the inspired air rises a greater and greater increase in the breathing is required to maintain this normal. It is, moreover, excess of carbon dioxide that excites the breathing. A corresponding deficiency of oxygen has no such effect.

It was found by Mr. Priestley and myself that a sample of the air in contact with the blood in the lungs could easily be obtained by catching the latter part of the air expired in a deep inspiration. As we expected, the percentage of carbon dioxide in this air turned out to be on an average practically constant for each individual.

If the frequency of breathing is voluntarily varied, even as widely as from three a minute to 60 a minute, the depth adjusts itself so as to keep the average alveolar percentage of carbon dioxide almost absolutely steady; and conversely if the depth is varied. With resistance to breathing there is a similar effect. The effort put into inspiration and expiration is so increased as to overcome the resistance and keep the alveolar carbon dioxide almost steady. If the breathing is temporarily interrupted or abnormally increased, the time is made up afterwards, so that the average alveolar carbon dioxide percentage is practically steady. If, finally, the inspired air is vitiated by carbon dioxide, the breathing is so increased as to keep, if possible, the alveolar percentage approximately steady.

The effects discovered by Hering and Breuer appeared to them to depend simply on the state of mechanical distention of the lungs, and to have no relation to the chemical regulation of breathing. Mr. Mavrogordato and I have quite recently reinvestigated these phenomena in man. The results showed that the amounts of inflation or deflation needed to produce the Hering-Breuer effects depend entirely on the chemical stimulus of carbon dioxide. When this stimulus is absent, as in apnea, a very slight inflation or deflation will suffice, so that the breathing is, as it were, jammed during apnea; while if the chemical stimulus is strong it needs a great inflation or deflation to produce the Hering-Breuer effect. The vagi prevent useless prolongation of inspiratory or expiratory effort and consequent waste of time in breathing, or damage to the lung structure. They also coordinate the discharges of the center with actual inflations or deflations of the lungs. When the vagi are cut the breathing becomes slow, and; as Scott showed, can only imperfectly respond to an increased chemical stimulus, since the frequency can not be increased. The influence of the vagi is entirely in the direction of keeping the alveolar air normal. Perhaps nothing illustrates more clearly the dependence of nervous reactions on more fundamental physiological conditions than the varying response of the respiratory center to the stimulus of inflation or deflation of the lungs.

When excessive ventilation of the lungs

is so arranged that there is no fall in the alveolar percentage of carbon dioxide, no apnea follows. There is thus no such thing as the so-called vagus apnea. Apnea is simply due to excessive removal of carbon dioxide from the alveolar air.

When the barometric pressure is varied it becomes evident that the normal which dominates the regulation of breathing is not the percentage of carbon dioxide in the alveolar air, but the partial pressure or molecular concentration. At the normal atmospheric pressure of 30 inches there is about 5.6 per cent. of carbon dioxide in the alveolar air, but only 2.8 at 60 inches barometric pressure, and 1.4 at 120 inches. In these three cases the percentage of CO_2 varies widely, but the partial pressure is the same. It is only with constant barometric pressure that the normal pereentage is steady.

When the breathing is increased by excess of CO_2 in the inspired air, or increased production of CO_2 in the body, there is, as might be expected, a slight rise in the alveolar CO_2 percentage. It is this slight rise that is the stimulus to increased breathing. Roughly speaking, a rise of 0.2 per cent. increases the resting breathing by 100 per cent., while a fall of 0.2 per cent. produces apnea. The stimulus of the increased CO_2 percentage is conveyed to the respiratory center by the blood. Under ordinary average conditions the center responds with normal breathing when the blood leaving the lungs is saturated with air containing 5.6 per cent. of CO_2, but does not respond at all when the blood is saturated with 5.4 per cent. of CO_2 or less. The threshold value of CO_2 is, however, greatly lowered by excessive administration of acids or in any condition of so-called acidosis, and is raised by alkalies or an alkaline diet. This and other evidence points to the fact that CO_2 acts on the respiratory center in virtue of its acid properties when in solution.

According to modern ideas the acidity or alkalinity of a liquid depends on its hydrogen ion concentration. The accurate measurement of the hydrogen ion concentration of blood by the electrometric method is attended with great difficulties; but these have been to a large extent overcome by Hasselbalch of Copenhagen, who has obtained measurements of the effects of saturation with different partial pressures of CO_2 on the hydrogen ion concentration of blood. He has also shown experimentally that when the alveolar CO_2 threshold is lowered or raised by an acid or alkaline diet this raising or lowering is just sufficient to keep the hydrogen ion concentration of the arterial blood sensibly steady. It is now certain, therefore, that what the respiratory center is reacting to when it reacts to a slight increase in the alveolar CO_2 percentage is the consequent slight increase in the hydrogen ion concentration of the blood.

The latter increase is so minute that it can only be detected electrometrically when it is of sufficient extent to produce very gross changes in the breathing. The respiratory center is enormously more delicate as an index of change in hydrogen ion concentration of the blood than any existing physical or chemical method.

As already remarked, the alveolar CO_2 percentage is extremely steady under ordinary resting conditions. This implies that the hydrogen ion concentration of the blood is regulated with almost incredible delicacy, and must be so regulated apart altogether from the breathing. The breathing simply regulates the rapid disturbances in hydrogen ion concentration caused by variations in the production of CO_2: other disturbances are regulated otherwise than by the breathing. There is clear evidence

that both the kidneys and the liver play a part in this regulation; but of the marvellous accuracy of the regulation physiologists had, till the recent work on the physiology of breathing, no clear conception.

It is not merely the hydrogen ion concentration of the blood that is accurately regulated, but also its capacity for taking up a constant amount of CO_2 in presence of a constant partial pressure of this gas. This capacity depends on the concentration of and balance between alkaline salts and albuminous substances in the blood. Recent investigations by Christiansen, Douglas and myself have shown that this concentration and balance are so accurately maintained day by day, and month by month that under normal conditions no deviations can be detected by the most delicate existing method of blood gas analysis. The balance can be temporarily upset by what may be called violent means; but within an hour it is back again to normal. It is, of course, evident that if the carrying-power of blood for CO_2 did not remain normal the breathing and circulation would not, without special adjustment, remain normal.

Now let us look back for a moment, and see where we now stand. The experimental study of the physiology of breathing has led us to the discovery of four normals, the maintenance of which furnishes the interpretation of a mass of what would otherwise be isolated and unintelligible observations. We have first of all the normal alveolar CO_2 pressure. This turns out to be directly subordinate to the normal regulation of the hydrogen ion concentration of the blood, the normal reaction of the respiratory center to hydrogen ion concentration, and the normal regulation of the capacity of the blood for carrying CO_2. With the discovery of each of these normals we have obtained deeper and deeper insight into the physiology of breathing. We have done this, not by merely seeking for causes in the physical sense, but by seeking for interconnected normals and their organization with reference to one another and to other organic normals. These normals represent, not structure in the ordinary physical sense, but the active maintenance of composition. We may fitly call this living structure, since so far as we know all living structure is actively maintained composition, the atoms and molecules entering into which are never the same from moment to moment according to the ordinary physical and chemical interpretation. Our method has thus been essentially the same as that of the anatomist who seeks for the normal—the type—which runs through and dominates the variety of detail which he meets with, and who reaches more and more fundamental types.

I wish, now, to point out that the same method has been applied, and is being applied, to other departments of physiology, even though the physiologists applying it may have failed to realize the far-reaching significance of their results.

I will refer first to the general physiology of the blood. The facts that the hydrogen ion concentration and capacity for carrying CO_2 are very accurately regulated in the blood are no isolated facts in physiology, although the accuracy of our physiological means of measurement renders them peculiarly striking. Claude Bernard, in his *Leçons sur les phénomènes de la vie,* was, I think, the first to point out clearly that the composition of the blood, as well as its temperature, is physiologically regulated. He was led to this conclusion more particularly by his observations that in prolonged starvation there is still sugar in the blood, and that even when great excess of sugar is intro-

duced into the body the percentage in the blood remains very steady, as excess is taken up by the liver and other organs, or excreted by the kidneys. Voit's observations on the relative constancy of the sodium chloride in the blood, and the manner in which the kidneys regulate this percentage, are of a similar character. If food freed from chloride is administered the elimination of chloride by the urine diminishes to almost nothing, though the high percentage of chloride in the blood-plasma remains about the same. As Voit also showed, the blood during prolonged starvation retains its normal composition, and its volume remains proportional to body weight, while other tissues (*e. g.*, muscle) are reduced.

Dr. Priestley and I have recently investigated the excretion of water by the kidneys. By simply drinking large quantities of water one can produce an enormous increase in the secretion of urine, and this urine is almost pure water. What we wished to observe was the degree of watering down of the blood which was necessary to produce the huge increase in excretion of water. We did not doubt that the watering down would be very small, but when we attempted to measure the dilution by determining the percentage of hemoglobin we found that there was no dilution at all, though the method used was one of extreme accuracy. When, however, the plan of measuring the electrical conductivity of the serum was adopted, a slight, but quite distinct, diminution in the conductivity could be detected during, and ending with, the diuresis. This showed that there was a slight diminution in the salt-concentration, and to this diminution the secreting cells were reacting. Here, then, we are in presence of another exactly but elastically regulated normal, the slightest deviation from which produces, in the kidneys, a reaction comparable in its exquisite delicacy with the reaction of the respiratory center or liver or kidneys to a change in hydrogen ion concentration.

The physiology of the kidneys has, in accordance with prevalent physiological conceptions, been attacked from the side of "causal" explanation. I know nothing more hopeless than the attempts to explain the outstanding features of secretion of urine on the lines of ordinary physics and chemistry. So far as the facts are yet known we can, however, get a practical grasp of the kidney activities if we attack the subject from the standpoint of the active maintenance of the normal blood composition.

Let me turn now to the general physiology of nutrition. In the preliminary stages of investigation of this subject physiology has owed much to the pure chemists, and this debt is constantly increasing. We have only to think of the work of such men as Black, Priestley, Lavoisier and Liebig. Like Wöhler, who synthesized urea, Liebig was a convinced vitalist. For him there was a central kernel of vital activity under the control of the "vital force"; but outside this central kernel he interpreted the phenomena of nutrition on purely chemical lines. He thought of oxygen as something free to oxidize anything oxidizable within the body, except what is protected by the vital force; and he assumed that the greater the concentration of oxygen in the lungs, and the greater the supply of food-material to the body, the greater will be the amount of oxidation, since only a limited amount of oxidation is under the direct control of the vital force. He gave special attention to the elimination of urea and other products of nitrogenous oxidation, and introduced methods of measuring the nitrogenous waste. It was found, apparently in direct confirmation of his general ideas,

that the amount of urea excreted rises and falls, except for a certain starvation minimum, in direct proportion to the amount of albuminous food eaten. The excess over the starvation minimum was looked upon as "luxus consumption"—an ungoverned oxidation, due to simple chemical factors.

But the matter was soon carried further by the physiologists—particularly by Pflüger, and by Voit and his pupil Rubner. It was found that, other conditions being equal, the consumption of oxygen is within wide limits independent of the abundance of its supply, and that the actual consumption of oxygen per unit of body weight is very little different during starvation from what it is when abundant food is supplied. In starvation more fat is being oxidized to compensate for the deficiency in albuminous oxidation. Finally, the brilliant work of Rubner established the fundamental fact that within very wide limits different food substances are simply substituted for one another within the organism in direct and exact proportion to the energy which they furnish when broken down. The energy liberation per unit body weight is practically constant, but if excess of food is taken the excess of potential energy is stored up as fat and glycogen, while if food is withheld the stored excess is used up. Even when all the stored fat and glycogen is used up, the organism finally flings its own living structural substance into the balance, and in this last desperate effort to maintain the normal metabolism the nitrogenous oxidation again rises to an amount which for a short time compensates for the energy previously yielded by fat. When death from starvation at length comes the old flag—the flag of life—is still flying.

The massive work of Atwater and his pupils on human nutrition, in which it was shown that the normal daily food requirement of a man is about 3,500 calories in energy-value, was of course a direct extension of the idea of normal nutrition. We maintain an energy consumption of about 3,500 calories, just as we maintain about 5.6 per cent. of CO_2 in our alveolar air, or hemoglobin of 18.5 per cent. oxygen capacity in our blood, or legs of a certain length and anatomical structure. By a strange confusion of ideas the idea is abroad that nutrition is a matter of simple chemistry and physics, and that when we estimate food values in calories, we are exemplifying this fact. This is enough to make a staunch old vitalist like Harvey or Johannes Müller turn round in his grave and laugh. What is it in the body that measures out or withdraws protein, carbohydrate and fat with meticulous accuracy in terms of their energy value, in such amount as to maintain the normal energy metabolism? Is it not the vital spirit or vital force? the old physiologists would ask. Is not this phenomena of a piece with all the other distinctive phenomena of life, and ought not physiology to face these phenomena fairly and squarely and generalize from them, not run away from them? This is the question I am trying to put to you now.

Now I wish to make it clear that it is not vitalism, but simply biology, that I am preaching. Vitalism is a very roundabout and imperfect attempt to represent the facts. Physiological study, and biological study generally, seems to me to make it clear that throughout all the detail of physiological "reaction" and anatomical "structure" we can discern the maintenance of an articulated or organized normal. This idea brings unity and light into every corner of physiology. In other words, it helps us within limits to predict, just as the ideas of unalterable mass and energy help us within limits to predict, or the ideas of time and space help us within limits to predict. I claim nothing more for it, but also nothing less. The idea of life is just

the idea of life. One can not define it in terms of anything simpler, just as one can not define mass or energy in terms of anything simpler. But this one can say—that each phenomenon of life, whether manifested in "structure" or in "environment," or in "activity," is a function of its relation to all the other phenomena, the relation being more immediate to some, and less so to others. Life is a whole which determines its parts. They exist only as parts of the whole.

At first sight it might seem as if it must be very difficult to make use of this conception as an instrument of research: for evidently we can not investigate the parts without investigating the whole. The difficulty is only apparent. The whole is there, however little we as yet comprehend it. We can safely assume its presence and proceed to discover its living details piece by piece, in so doing adding to our knowledge of the whole. If, on the other hand, we attempt to take the organism to pieces, or separate it from its environment, either in thought or in deed, it simply disappears from our mental vision. A living organism made up of matter and energy is like matter and energy made up of pure time and space: it conveys to us no meaning which we can make use of in interpreting the facts.

But is there not matter and energy in a living organism? Do we not assume this at every step in physiology? We make use of the ideas of matter and energy in biology, just as the physicist makes use of the idea of extension in the investigation of matter. To the biologist, however, the structure and activity of an organism are no mere physical structure and activity, but manifestations of life, just as to the physicist the extension of matter is no mere mathematical extension, but a manifestation of the properties of matter, with a physical and not a mere mathematical meaning. This is the answer to those who point to the dependence of physiology on physics and chemistry, and conclude from this that physiology can not be anything but a department of physics and chemistry. By a similar chain of reasoning physics would be nothing but a branch of mathematics, and mathematics itself would melt away into that universe of unconnected "impressions" which David Hume imagined, but Immanuel Kant showed to be nonexistent.

The limits of time prevent my giving further examples of the light which the conception of the normal throws on the details of every part of physiology, and I must now try to probe more deeply. It may be pointed out that although it is useful in matters of detail to bear in mind that a living organism tends to maintain a normal of both structure and activity, and to pass through a normal life history, yet in ultimate analysis all this *must* be due simply to the reactions between its structure and physical and chemical environment. I will not at this point quarrel on general grounds with the "must," but simply endeavor to test it by the facts of physiology.

We can distinguish in a living organism what seems a more or less definite structure of bony matter and connective tissue. Yet we know that all this is built up, and in adult life is constantly being pulled down, rebuilt and repaired, through the activities of living cells. It is thus within the living cells that we must look for the structure which is supposed to react so as to maintain the normal. These cells are made up of what has been called "protoplasm." Now the more we study protoplasm the more evident does it become that this "substance" is extraordinarily sensitive to the minutest changes in environment. Take away or diminish or increase the minute traces of calcium or potassium

salts in the blood-plasma, or the traces of various substances supplied to the blood by other organs; or add traces of certain other substances: the reactions of the protoplasm are quickly altered, and its structure may be destroyed. It is evidently in active relation with its environment at every point, and one can not suspend this activity without altering it. Even deprivation of oxygen for, perhaps, a minute may kill a nerve-cell. There is no permanent physical structure in the cell: the apparent structure is nothing but a molecular flux, dependent from moment to moment on the environment.

Now when we look at the blood, the internal or immediate environment on one side of the cells in the body, we find, as already shown, that this is almost incredibly constant in composition. Were it not so the reactions of the cells would become chaotic, and their structure would be completely altered if not destroyed. But the constancy of the blood is maintained by the combined reactions of the organs and tissues themselves. The intimate structure of the living cells depends on the constancy of the blood, and the constancy of the blood depends on the intimate structure of the tissues. If we regard this condition as simply a physical and chemical state of dynamic balance, it is evident that the balance must be inconceivably complicated and at the same time totally unstable. If at any one point in the system the balance is disturbed it will break down, and everything will go from bad to worse.

A living organism does not behave in this way: for its balance is active, elastic, and therefore very stable. When a disturbance affects its structure or internal environment it tends to "adapt" itself to the disturbance. That is to say its reactions become modified in such a manner that the normal is in essential points maintained. An injury heals up: destroyed tissue is reproduced, or other parts take on its function: the attacks of microorganisms are not only repelled, but immunity to future attacks is produced. In reproduction the body periodically proceeds to renew almost the whole of its structure. Death may be regarded as a periodical scrapping of structural machinery, and reproduction as its complete renewal.

The Anglo-American expedition of which I was a member studied, on the summit of Pikes Peak, Colorado, adaptation to the want of oxygen which causes, in unadapted persons, all the formidable symptoms known as "mountain sickness." As adaptation proceeded the blueness of the lips, nausea, and headache completely disappeared, and it was then found that even during rest the lung epithelium had begun to secrete oxygen actively inwards. The kidneys and liver were now also regulating to a lower degree of alkalinity in the blood, so that the alveolar CO_2 pressure was diminished, and the breathing consequently increased, thus raising the oxygen-supply to the lungs. There was also a marked increase in the hemoglobin percentage and in the blood volume. The organism had so adapted itself as nearly to compensate for the deficiency in oxygen supply, just as a heart gradually compensates for a permanent valvular defect.

The normals of a living organism are no mere accidents of physical structure. They persist and endure, and they are just the expression of what the organism is. By investigation we find out what they are, and how they are related to one another; and the ground axiom of biology is that they hang together and actively persist as a whole, whether they are normals of structure, activity, environment or life history. In other words organisms are just organisms and life is just life, as it has always seemed to the ordinary man to be. Life as such is a reality. Physiology is therefore a

biological science, and the only possible physiology is biological physiology.[3] The new physiology is biological physiology—not bio-physics or bio-chemistry. The attempt to analyze living organisms into physical and chemical mechanism is probably the most colossal failure in the whole history of modern science. It is a failure, not, as its present defenders suggest, because the facts we know are so few, but because the facts we already know are inconsistent with the mechanistic theory. If it is defended it can only be on the metaphysical ground that in our present interpretation of the inorganic world we have reached finality and certainty, and that we are therefore bound to go on endeavoring to interpret biological phenomena in the light of this final certainty. This is thoroughly bad metaphysics and equally bad science. It is the idea of causation itself that has failed, and failed because it does not take us far enough. We have not at present the data required in order to connect physical and chemical with biological interpretations of our observations; but perhaps the time is not far off when biological interpretations will be extended into what we at present look upon as the inorganic world. Progress seems possible in this direction, but not in the direction of extending to life our present every-day causal conceptions of the inorganic world.

I now wish to add a few words as to the relation of physiology to medicine; for I am one of those with an intense belief in the intimate connection between the two sciences, and it seems to me that the mechanistic physiology of the nineteenth century has failed to take the rightful position of physiology in relation to medicine. What is the practical object of medicine? It is to promote the maintenance and assist in the reestablishment of health. But what is health? Surely it is what is normal for an organism. By "normal" is meant, not what is the average, but what is normal in the biological sense—the condition in which the organism is maintaining in integrity all the interconnected normals which, as I have already tried to indicate, manifest themselves in both bodily structure and bodily activity.

Now for the mechanistic physiology there are no interconnected normals, just as in the inorganic world as at present interpreted there are also no interconnected normals. If we look through an average existing text-book of physiology we find a great deal about the effects of this or that stimulus, a great deal also about the external mechanism and chemistry of bodily activity—a great deal, in other words, about what lies on the surface but never takes us further. Along with this there are perhaps also some inconclusive discussions of the possible mechanism of such processes as physiological oxidation, secretion, growth, muscular contraction, or nervous activity. Very little will, however, be found about what in reality lies still more on the surface, but also penetrates deep down—the maintenance within and around the body of normal organized structure and activity. The maintenance of the normal is something for which there is no place in the mechanistic physiology, since according to this physiology maintenance must be in ultimate analysis only an accident of structure and environment—a fitful will o' the wisp which does not concern true science.

But medicine, as we have seen, is supremely interested in the physiological normal. What a man sees at the bedside is

[3] It has been suggested to me that if a convenient label is needed for the teaching upheld in this letter the word "organicism" might be employed. This word was formerly used in connection with the somewhat similar teaching of such men as Bichat, von Baer and Claude Bernard. *Cf.* Delage, L'Hérédité, Paris, 1903, p. 436.

a perversion of the normal, and nature's attempts to restore it, with what assistance medicine can give. For medicine it is necessary to know the normal in its elastic and active organization. He who knows how the body regulates its normal temperature will not confuse heat-stroke with fever, or make the mistake of attributing fever to mere increased heat-production in the body. He who knows how the breathing is normally regulated will be in a position to distinguish at once between various causes of abnormal breathing; and similarly for every abnormal symptom met with in disease. But the mechanistic physiology gives a minimum of information about the regulation of the normal. One looks in vain in physiological text-books for connected accounts of the regulation of breathing, circulation, kidney activity, general metabolism, nervous activity. The main facts of physiology are partly ignored, and partly strewn about in hopeless disconnection and confusion. A student of medicine may learn some true physiology at the bedside, or he may never learn it at all, and become either a hopeless empiric or what I do not hesitate to call a mechanistic pedant.

Medicine needs a new physiology which will teach what health really means, and how it is maintained under the ordinarily varying conditions of environment. We also need a pathology which will teach how health tends to reassert itself under totally abnormal conditions, and a pharmacology which will teach us, not merely the "actions" of drugs, but how drugs can be used rationally to aid the body in the maintenance and reestablishment of health. The new physiology, new pathology, and new pharmacology are growing up around us just now. I can see them more particularly in the splendid advances which the medical and other biological sciences are making in America. You have the advantage of having less of old intellectual machinery to scrap than we have in the old countries; but perhaps we shall not be much behindhand.

If we look on pathology as simply the description of damage to bodily structure, and the analysis of the causes of this damage, then pathology may be very helpful in preventive medicine, but does not help much in therapeutics. When, however, pathology studies the processes of adaptation to the unusual, defence of the organism against the unusual, and reproduction of the normal, just as the new physiology studies the maintenance of the normal under ordinary conditions, then therapeutics and surgery will be aided at every step by pathology, and a rational biological pharmacology will have its chance.

Sometimes one hears the complaint that the world has grown old: that the great discoveries have all been made; and that nothing is left to us now but to work out matters of sheer detail. Perhaps the great and constantly growing mass of rather uninteresting, but otherwise apparently meritorious scientific literature, increases this impression. At certain moments one may long for the past centuries when there was much less to read, and people seemed to have plenty of time to think, and to have endless material for new discoveries and projects. But in reality I do not think that there was ever more scope for new ideas and discoveries than there is at present. Among the new ideas are those of the new physiology, the outlines of which I have tried to trace in this lecture. Those who do not feel inclined to accept this new physiology, or who are still sceptical as to its theoretical basis, will, I hope, at least make allowance for any personal failure on my part to present it to them in a more convincing form.

J. S. Haldane

New College,
University of Oxford

THE UNIVERSITY OF ILLINOIS HUDSON BAY EXPEDITION

The University of Illinois geological expedition into the Hudson Bay region during the past summer, which was made possible by a grant from the graduate school, has been completed recently with very successful results.

The primary purpose of the expedition was to make a detailed study of the succession of Paleozoic rocks comprising the great sedimentary outlier west of Hudson Bay, with the object of determining just what formations are represented in that region: a fact of first importance in interpreting the oceanic connections of the ancient epicontinental seas, and the paleogeography of the continent during early Paleozoic time.

Inasmuch as the only source of supplies and provisions throughout a large part of the region is the various fur-trading posts of the Hudson's Bay Company, arrangements were made to outfit through this company at The Pas, Manitoba. The start was made from that place on July 4, the party going as far as Armstrong lake on the new Hudson Bay railroad, and then proceeding down the Nelson river by canoes to the Bay.

Over nearly the entire region bordering Hudson Bay on the west the land is a great muskeg, or swamp, covered with a blanket of peat varying from a few inches up to ten feet or more in thickness. Owing to this fact the country back from the streams is almost impassable in the summer, there being no overland trails except portage paths around rapids in the rivers, or across the low divides from one river system to another. Hence, the party was obliged to travel entirely by canoes.

The exposures of the sedimentary rocks in this region are practically confined to the banks of the larger rivers which, almost without exception, flow across the belt of sedimentary strata. These rocks dip in general towards the bay at a rate a little greater than the fall of the streams, thereby making it possible to obtain a practically complete section of the strata outcropping along each stream. The plan of work was to follow up a river, portage across the divide into the adjacent river basin, follow that down to the Bay, proceed along the coast of the Bay to the next important river, ascend this, cross the divide and follow down the next, etc. In this manner a detailed section of the rocks and a careful collection of fossils were obtained from the Ordovician strata exposed along the Nelson, and Shamattama rivers; from the Silurian rocks along the Severn, Winisk, and Ekwan rivers, and from the Devonian beds, at the south end of the Bay, along the Moose and Abitibi rivers.

Altogether about eighteen hundred miles were traversed by canoes on this expedition, the party reaching the railroad at Cochrane, Ontario, on September 18.

A detailed report containing the scientific results of the expedition will be published as soon as the fossil collections which it was necessary to leave for shipment at the various posts of the Hudson's Bay Company reach the university and can be carefully studied.

T. E. Savage,
F. M. Van Tuyl
Department of Geology,
University of Illinois

SCIENTIFIC NOTES AND NEWS

Dr. Cleveland Abbe, the distinguished meteorologist, died on October 28, at his home in Chevy Chase, Washington, in the seventy-eighth year of his age.

Dr. Wilhelm von Waldeyer, professor of anatomy in the University of Berlin, has been raised to hereditary nobility on the occasion of his eightieth birthday.

A finely illustrated volume, containing thirty-six articles and extending to over eight hundred pages, has been dedicated to Dr. Erik Müller, professor of anatomy at the University of Stockholm, by his friends and pupils on the occasion of his fiftieth birthday.

Professor C. W. Balke, formerly at the head of the division of general chemistry and qualitative analysis at the University of Illinois, is organizing a research laboratory for the Pfanstiehl Company in North Chicago

which is engaged in the application of rare metals to industrial uses.

Dr. H. S. Adams, of the department of physiological chemistry in the University of Chicago, has accepted a position as research chemist and pharmacologist at the biological laboratories of E. R. Squibb & Sons, New Brunswick, N. J.

Dr. William Gilman Thompson, professor of medicine in the Medical College of Cornell University, has resigned, and is succeeded by Dr. Lewis Atterbury Conner, professor of clinical medicine in the college since 1905.

Dr. Arminius C. Pole, after many years' service as professor of anatomy in the Baltimore Medical College and professor of descriptive anatomy in the University of Maryland since the merger of the two schools in 1913, has resigned.

C. F. Hirshfield, professor of power engineering in Sibley College, Cornell University, who has been absent on leave for special work in Detroit, has resigned.

W. C. Phalen has resigned his position as geologist in the U. S. Geological Survey and has entered on his new duties as a mineral technologist in the Bureau of Mines, with headquarters in Washington.

Professor Ernest Blaker, of the department of physics, Cornell University, has, on account of illness, been granted leave of absence for the present term.

Dr. Charles L. Parsons, of the Bureau of Mines, is in Europe, where he will spend two months visiting plants in connection with the United States work preparatory to constructing a nitrate plant.

Dr. Henry I. Adler, lately chief of staff of the Boston Psychopathic Hospital, is spending several months in Chicago at the request of the Civic Club and the Illinois Society for Mental Hygiene, under the auspices of the Rockefeller Foundation. His especial work is to be a survey of the mental defectives of Chicago and Cook County, and he will work in the courts and other institutions where there are facilities for detecting and handling defectives.

Dr. Clark Wissler, of the American Museum of Natural History, during the summer, continued his work with Mr. James R. Murie, chief of the Pawnee Indians of Oklahoma. With the aid of Mr. Murie, Dr. Wissler has secured many interesting rituals of the religion of the Pawnee, which is now passing away. The more important parts of these rituals have been written down as texts in the Pawnee language with translations in English.

Dr. Frank E. Lutz, of the American Museum of Natural History, and Mr. J. A. G. Rehn, of the Academy of Natural Sciences of Philadelphia, spent part of the summer studying and collecting insects in the vicinity of Tucson, Arizona. Mr. B. Preston Clark generously contributed toward the field expenses and the Philadelphia Academy also cooperated in the work. In addition to securing specimens for the study collection, an effort was made to obtain material which would bear especially upon the problems of ecological and geographical distribution.

At the opening exercises of the College of Medicine of the University of Illinois, held in Chicago, on October 5, Edmund J. James, president of the university, delivered an address on the "Function of the State in the Promotion of Medical Education and Research."

At the annual meeting of the American Roentgen Ray Society, held in Chicago the last week in September, Professor W. S. Miller, of the department of anatomy at the University of Wisconsin, delivered by invitation an illustrated address on "The Architecture of the Lung and its relation to the Proper Reading of X-ray Plates."

Professor Bird T. Baldwin, of Swarthmore College, has been appointed lecturer in education at the Johns Hopkins University. He is giving, on Saturdays, a course on "Educational Measurements," continuing the special work he began in the university's summer session.

Dr. Percival Lowell, director of the Lowell Observatory, Flagstaff, Ariz., left Boston on September 27 for an extensive astronomical

lecture trip. He is speaking at the State College of Washington, University of Washington, Reed College, Oregon Agricultural College, University of Oregon, Leland Stanford Junior University and the University of California. Before returning he will spend some time at his observatory in Flagstaff.

Professor Emmanuel de Martonne, professor of geography in the Sorbonne, arrived in New York on September 18 to take up his work as visiting French professor at Columbia University. He is giving courses on European physiography under the auspices of the department of geology. His offerings include two courses of four lectures each, delivered in French and open to the public. The subjects and dates of these lectures are: (1) Montagnes du Centre et Sud de la France, 4:15 P.M. (Massif Central), October 19 and 26, November 2, and (French Alps) November 9; (2) Plaines et Champs de Bataille du Nord de la France, 8:15 P.M., November 15, 22 and 29, and December 6. In connection with this series of lectures, there are conferences, open to advanced students, in which a detailed study of certain phases of the work will be made. Professor de Martonne is also cooperating with Professor D. W. Johnson in a course on the physiography of Europe, in which the Alps, the Carpathians, and southeastern Europe will be discussed by Professor de Martonne.

The New York sections of the American Electrochemical Society and the Illuminating Engineering Society have arranged for a joint session to be held at the Engineering Societies Building, 29 West 39th St., New York, on Thursday evening, November 9, at 8 o'clock. A program has been prepared including papers on "High Pressure Gas Installations," "The Chemistory of Gas Lighting" and "The New Flexible Mantle." Engineers and chemists interested are cordially invited to attend.

The Thomas Hawksley lecture of the British Institution of Mechanical Engineers was delivered by Mr. H. E. Jones, on November 3, on the subject of "The Gas Engineer of the Last Century."

We learn from the *British Medical Journal* that at the recent general meeting of the Medical Society of London, the retiring president, Sir St. Clair Thomson, drew attention to a plaque removed from the society's house in Bolt Court to the present library. The plaque was erected originally by Dr. John Coakley Lettsom, the founder of the society. The incoming president, Lieutenant-colonel D'Arcy Power delivered an address on "John Ward and His Diary." The Lettsomian lectures will be delivered by Colonel Cuthbert Wallace, C.B., and the oration by Sir William Osler.

Dr. Louis McLane Tiffany, emeritus professor of medicine at the University of Maryland, and consulting surgeon for the Johns Hopkins Hospital, died on October 23, at seventy-two years of age.

Pictures of surgery done by Dr. Alexis Carrel and others on the wounded soldiers in French hospitals have recently been made with a cinema camera and brought to this country by the Clinical Film Company. The picture will be shown before medical societies and medical students.

UNIVERSITY AND EDUCATIONAL NEWS

The General Education Board has announced the following appropriations: Albion College, Albion, Mich., $100,000; George Peabody College for Teachers, Nashville, Tenn., $200,000; Hamline University, St. Paul, Minn., $100,000.

Isaac F. Nicholson, Baltimore, celebrated his eightieth birthday by giving the Johns Hopkins University $15,000 for the establishment of the Isaac Forester Nicholson Fund, to establish scholarships for needy students from Baltimore or the state of Maryland, or to be used for any other purpose the trustees may desire.

Bishop Candler, chancellor of Emory University, announces the receipt of a contribution of $50,000 from J. J. Gray, Jr., Rockdale, Tenn., for the erection of an outpatient building in connection with the medical department

of Emory University, the building to be known as the J. J. Gray Clinic.

Orson Bennett Johnson, professor emeritus of zoology in the University of Washington, has given the university his valuable entomological collection.

Dr. J. Ernest Carman, of the University of Cincinnati, has been appointed to the chair of geology at the Ohio State University vacant by the death of Professor Charles S. Prosser.

Dr. Julius H. Hess has been appointed professor of pediatrics and head of the division of pediatrics in the University of Illinois, college of medicine.

Dr. Frank Maltauer, formerly of the Cincinnati Board of Health, has become associate professor of bacteriology and public health at the College of Medicine, University of Tennessee.

Dr. Alban Stewart, instructor in botany at the University of Wisconsin, has been appointed professor of botany and bacteriology in the Florida State College for Women, Tallahassee, Florida.

Dr. R. L. Borger, of the University of Illinois, has been appointed professor of mathematics at Ohio University, Athens, Ohio.

Dr. Edward Hart has retired as active head of the chemical department of Lafayette College, but remains connected with the department as professor of chemical engineering and as librarian of the Henry W. Oliver Chemical Library. Dr. Eugene C. Bingham has resigned the professorship of chemistry at Richmond College to become professor of chemistry and director of the Gayley Laboratory at Lafayette College. Last year Dr. Bingham was on leave of absence from Richmond College in order to carry out some special investigations at the Bureau of Standards on the subjects of fluidity and plasticity. Dr. J. Hunt Wilson, of Lehigh University, has become assistant professor of chemistry at Lafayette College.

J. F. Wilson, formerly instructor in electrical engineering at the University of Michigan, has been appointed professor of electrical engineering at Queen's University, Kingston, Canada, to take the work of Professor L. W. Gill, while the latter is in active military service.

DISCUSSION AND CORRESPONDENCE

SUNLIGHT AND THE MAGNETIC NEEDLE

The editorial page of the *Electrical World* for April 1, 1916, contains the following paragraph pertaining to the subject of magnetism and terrestrial magnetism:

> Considering how many centuries have elapsed since magnetic phenomena first became recognized on this planet, it is remarkable how little has yet been learned concerning the nature and laws of magnetism. All that we are able to affirm, with a reasonable degree of certainty, is that whatever electricity and magnetism may be, they must be so interrelated that one is the consequence of the curl of the other, which is one aspect of Maxwell's electromagnetic theory.
>
> As an instance of our magnificent international ignorance of the nature of terrestrial magnetism, the simple historical fact may be cited that in 1582, the date of the international introduction of the Gregorian Calendar, with a sudden jump of ten days, the magnetic needle at London pointed 11 degrees easterly of the geographic meridian, whereas it now points nearly 16 degrees westerly of that meridian, and in 1820 nearly attained 25 degrees of westerly declination, a total of more than 36 degrees, while no satisfactory theory of the large change has yet been produced.

The foregoing is particularly interesting to the writer, who is directly interested in collecting ocean data on the non-magnetic ship *Carnegie* to be used, first, practically in constructing charts for navigation and, second, in theorizing on the causes of the earth's magnetism and on its changes as referred to. I desire to call attention to the work of the Department of Terrestrial Magnetism of the Carnegie Institution of Washington, D. C., in the making of extensive magnetic observations leading to the formation of some correct theory of the causes of the earth's magnetism.

The writer wishes to contribute the following on the general subject of magnetism, of whatever value it may be.

So far as I am aware neither Faraday in his experimental researches nor Maxwell in his mathematical treatment thereof, nor any one else recently, ever proposed or performed an experiment, excepting the experiments with polarized light, to show that a direct connection existed between light and magnetism.

At the end of Faraday's first period of brilliant discoveries or about 1841 various investigators[1] had performed many experiments with this end in view.

In general these had taken the form of attempts to magnetize bodies by exposure in particular ways to different kinds of radiations; and a successful result had been more than once reported only to be proven in error on re-examination.

Sir John Herschel was the first to indicate the true path of procedure. He wrote:

> Induction led me to conclude that a similar connection exists, and must turn up somehow or other, between the electric current and polarized light and that the plane of polarization would be deflected by magneto-electricity.

Faraday had already discovered the nature of this connection in 1834, but had considered his experiment a failure. In 1845 after Herschel's remark he varied the original experiment, with success, by placing a piece of heavy glass between the poles of an excited electro-magnet; and found that the plane of polarization of a beam of light was rotated when the beam passed through the glass parallel to the magnetic lines of force composing the field. This constituted the discovery of the connection between light and magnetism.

In 1851 Faraday wrote:

> It is not at all unlikely that if there be an *æther*, it should have other uses than simply the conveyance of radiation.

This sentence has been considered the origin of the electro-magnetic theory of light.

The question which natural philosophers had never ceased to speculate on, that of the manner in which electric and magnetic influences are transmitted through space, assumed a definite form about the middle of the nineteenth century and issued in a rational theory. It was at this point that the whole matter was taken up and eventually theoretically solved by Maxwell. He said:

> We can scarcely avoid the inference that light consists in the transverse undulations of the same medium which is the cause of electric and magnetic phenomena.

At the time Maxwell did not examine whether this relation was confirmed by experiment. For years the electromagnetic theory was beset with difficulties and was unfavorably received by his most famous contemporaries. Helmholtz after many years accepted it, but Lord Kelvin, it seems, never did.

It is quite interesting to note here that Lord Kelvin in 1904 admitted that a bar magnet rotating about an axis at right angles to its length is equivalent to a lamp emitting light of period equal to the period of rotation, giving his final judgment, however, that "the so-called electro-magnetic theory of light has not helped us hitherto."

While pondering over the subject of terrestrial magnetism, electricity and magnetism on the night of Tuesday, March 7, 1916, the following thought came to me with such force that I set it down in my diary. A copy is as follows:

> I conceived the idea to try the effect of a concentrated sunlight on the magnetic needle or magnetized bar of any kind. The question being will not the concentrated light lessen or strengthen the magnetism of the magnet?

In performing such an experiment arrangement must be made so as to exclude the effects of the absorbed energy appearing as heat. I intended to try this as an experiment at some convenient time in the hopes that some new connection might be brought about concerning the subject of light, electricity and magnetism and their mode of propagation.

On Saturday, March 11, 1916, four days afterwards, I chanced to see a newspaper clipping regarding some work of Professor T. J. J. See, of Mare Island, Cal. In this article Pro-

[1] Morichini, of Rome, 1813, *Quart. Journal of Science*, XIX., p. 338. S. H. Christie, of Cambridge, 1825, *Phil. Trans.*, 1826, p. 219. Mary Somerville, 1825, *Phil. Trans.*, 1826, p. 132.

fessor See proposed to explain many things, among them being "the direct effect of sunlight on a magnetic needle, as in Nipher's experiment of 1913." This was a complete surprise. Evidently this experiment had been tried with success by I suppose Francis E. Nipher, of Washington University, St. Louis, Mo.

It seems to me that such an experiment would be valuable to science in many ways. The question arises as to the quantitative effect produced—if appreciable, then might we not expect or predict a change in all magnets more or less with time—especially as they are exposed to the sunlight? It is well known that magnets lose some of their magnetism during the process of ageing. Might this effect be a contributing cause?

The question as to the effect on small magnets such as in use for the determination of the earth's magnetic elements assumes some importance when considered in this regard.

What might be the effect of the sunlight on the magnet if it were rotated about a horizontal line through its center of mass and perpendicular to its magnetic axis? The theory of magnetization by rotation has been treated in two articles appearing recently in SCIENCE by Barnett.

Aside from the foregoing it would be interesting to note the effect, if any, of radioactive emanations upon a magnetic needle.

There are two well-known cases of the transformation of luminous into electrical energy, the thermopile and the photo-electric cell. However, in neither one is the transformation direct, as would be the case of luminous energy falling upon the magnetic needle.

It would be interesting to see this matter investigated in the light of modern electrical theory and to know of Nipher's experiment and of the results obtained.

F. C. LORING
DEPARTMENT OF TERRESTRIAL MAGNETISM,
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GUMBOTIL, A NEW TERM IN PLEISTOCENE GEOLOGY

THE term gumbo has been used for many years by some geologists in America for a dense, impervious clay, which, when saturated with water, is sticky and tenacious. The name has had no relation to the origin of the material: in many cases it has been applied to alluvial deposits on the flood plains of streams: McGee, Leverett and others have applied it to a gray to drab-colored clay overlying drift, the origin of the gumbo having been attributed to various causes, some having considered it to be, mainly, of fluvio-glacial origin, others to be aqueous, and still others have thought it to be related to loess.

In a recent paper in volume 27 of the Geological Society of America, pages 115 to 117, the writer discussed a gumbo which lies on Kansan drift and which he had studied in considerable detail in southern Iowa. This gumbo is limited in distribution to tabular divides and other remnants of the Kansan drift plain. The view was there expressed that the field evidence suggested strongly that the gumbo is the result, chiefly, of the chemical weathering of Kansan drift. It was stated, also, that detailed chemical analyses of the gumbo and the underlying materials were being made by Dr. J. N. Pearce, of the chemistry department of the University of Iowa, to ascertain whether the analyses would strengthen or weaken the interpretations made from the field evidence. These analyses have now been completed and will soon be published. They seem to show clearly that the gumbo is the weathered product of the drift.

During the present summer, the writer has extended his studies into the western, northwestern and northern parts of Iowa, and at scores of places sections have been examined which show clearly the intimate relations between the gumbo and the underlying Kansan drift. Moreover, it is of interest that in many places a gumbo has been found on the Nebraskan drift, the relations of the gumbo to this drift being similar to those of the super-Kansan gumbo to the Kansan drift. Furthermore, after a somewhat careful study of the gumbo which lies on the Illinoian drift in southeastern Iowa, and which has been discussed by Leverett in Monograph XXXVIII. of the United States Geological Survey,

pages 28 to 33, the conclusion has been reached that here, also, the gumbo is so related to the drift that it is undoubtedly the thoroughly weathered product of the Illinoian drift.

As a result of the field investigations and the chemical studies it is now proposed that the somewhat indefinite term "gumbo" be no longer used for these super-drift clays, but that the name "gumbotil" be used. Gumbotil is, therefore, a gray to dark-colored, thoroughly leached, non-laminated, deoxidized clay, very sticky and breaking with a starch-like fracture when wet, very hard and tenacious when dry, and which is, chiefly, the result of weathering of drift. The name is intended to suggest the nature of the material and its origin, and it is thought best to use a simple rather than a compound word. Field work has already established the fact that in Iowa there are three gumbotils, the Nebraskan gumbotil, the Kansan gumbotil and the Illinoian gumbotil.

GEO. F. KAY

UNIVERSITY OF IOWA

THE EVOLUTION OF HERBS

THE article by Edmund W. Sinnott, published last week in SCIENCE, *44*: 291, supports conclusions on this subject arrived at from quite a different standpoint.

The idea that trees are primitive forms is involved in the proposition advanced by Henry L. Clarke, in the *American Naturalist*, *27*: 769–81, September, 1893, that in their order of blooming the generalized precede the specialized.

My observations were based only on entomophilous flowers, 493 native and 61 introduced.

If we assume that the earliest, least specialized, and primitive plants form the earliest maxima and succeed in regular order, we shall have for indigenous plants the following results according to the time of the maxima:

Trees	April 27–May 8
Woody climbers	June 13–15
Shrubs	June 21–23
Perennial herbs	August 2–6
Annuals and biennials	August 30–September 6

And this seems to be the probable order of their development. The original plants having the most freedom developed large size and occupied the most favorable positions. The less favored could become reduced to shrubs and finally to herbaceous perennials, and occupy many positions which were unfavorable for trees or with which trees did not interfere. The habits of perennial herbs are better understood if we suppose that they had to compete with trees, or rather avoid competition with them, from the first. The annuals developing later were able to find many temporary situations unfavorable for woody plants or perennial herbs. The primitive Angiosperms were probably trees, like Magnoliaceæ, Anonaceæ and Lauraceæ.

Another general characteristic of blooming seasons is that the earliest, most generalized, most primitive plants have the shortest seasons, while the most specialized, most recent, and latest arrivals have the longest seasons. Arranging the vegetative forms according to their average blooming seasons, we have the following order:

	Days
Woody climbers	36.5
Trees	39.4
Shrubs	42.7
Perennial herbs	57.1
Annuals or biennials	75.1
Cosmopolitan	80.4
Introduced	117.3

Except for trees and woody climbers, the order is the same as for the maxima.

CHARLES ROBERTSON

CARLINVILLE, ILL.,
September 6, 1916

HORSE FLESH AND THE DIET OF EARLY MAN

TO THE EDITOR OF SCIENCE: In SCIENCE, for September 22, is published a letter on the "Animal Diet of Early Man," which discusses the subject with reference to possible evidence drawn from tapeworms and their hosts. In this connection, the writer of the letter speaks of the horse as food, as follows:

> There is nothing to show that horses were not eaten, unless the rather widespread abhorrence of eating horse flesh at the present time can be con-

strued that man never adapted himself to that diet as he did to beef.

It is worth recalling that any such prejudice in European races is only a thing of yesterday, when discussing such a question as this, since horse flesh was eaten in parts of Europe at least for an apparently unlimited time. It went out of use when it was declared "unclean" by Pope Gregory III., who died in 741. This is discussed in a paper by Esser, on horse flesh, which appeared in the *Journal für Landwirtschaft*, 43 (1895), No. 3, pp. 349–358. The prohibition was so effective that horse flesh did not assume importance in Europe again until after 1870.

C. F. Langworthy
U. S. Department of Agriculture

ANOTHER TYPICAL CASE

To the Editor of Science: About a year ago a short article by Professor Pickering appeared in Science under the heading "A Typical Case." The point of the discussion was that a man who had been trained to a high technical efficiency in research had been obliged to take a position in which he was overworked and underpaid to such an extent that he had been forced to give up research because of lack of time and funds, particularly the latter. Thus the world at large loses the benefit of his experience and training.

I am personally interested in a closely related problem which I would like to have considered. I can illustrate it best, probably, by some account of my own experience and I am going to put it on a frankly personal basis, so that due allowance may be made for my own feeling in the matter. My first acquaintance with research was in some preliminary work on a problem in morphology. At that time I was on a fellowship stipend. Marriage at the end of the year made it impossible to continue on such a condition. In connection with high school teaching the line of study was shifted to a rough biological survey of the locality. This was interrupted by a shift in location and the next opportunity for advanced study happened to be in the line of history. A little later the unfortunate acceptance of a position with a bankrupt college caused me to be stranded in the middle of the year and I again took up my original problem in morphology. This study was advanced sufficiently by the end of the year to enable publication of a paper which received favorable comment from workers in that line, especially abroad. Overload in teaching for the next few years prevented any systematic research being done. Finally an opportunity came for attendance at another university, expenses being partly met by acting as half-time assistant. The results of research of that year were covered by a paper on regeneration. Since that time I have not been able to command sufficient funds to enable me to attend regular sessions of a university and support my family. I have had some summer-school study but not of a sort to give residence credit, I am informed.

For three and one half years now I have been working on a local plankton problem under the advice and direction of a university authority on that subject. For more than two years of that time I have averaged more than fifteen sixty-minute periods per week through fifty-two weeks of the year in study of quantitative and qualitative features of the problem. The value of half of that time has been at least trebled through the aid given by my wife in computing and recording. I am hoping to get my own paper into press this year. I have not been able to obtain any university credit for this work because it could not be counted "in residence." I would like to have a Ph.D. degree, because it seems that that is regarded as a necessary factor in finding a position which would enable me to support my family and still carry on the research in which I am so much interested. Since my efforts have almost exhausted my scanty resources, such a point is of very great interest to me.

I feel quite certain that my case is fairly typical in much the same way as the one mentioned by Professor Pickering. It may be that I have actually done more research than some of similar experience but there are individuals who have done more than I have. There are also a good many who could do acceptable research but who get off in small communities

without any chance of stimulus by personal contact with investigators and so allow their interest to die.

It is becoming more and more certain that amongst other bad features of our "educational system" there is a growing tendency to formation of caste distinctions. The high-school teacher to some extent assumes an exclusive air toward the grade teacher, the university teacher toward the high-school teacher. Within the universities teachers without doctor's degrees sometimes find an embarrassing attitude among their own fellows. A newly fledged doctor sometimes considers himself superior to an older man with a lower degree.

If the universities can not possibly grant higher degrees for extramural work, no matter how valuable, may it not be possible to devise a method by which recognition and encouragement may be given to those doing effective research not technically recognizable under university rules. Could a national council be assembled to confer some mark of merit upon such people? Could a society somewhat like Sigma Xi be formed for such a purpose? If something could be done and a high but reasonable standard maintained, a man with such recognition might stand as high or even higher amongst scientists than the mere doctor. For is not achievement in the face of adversity of greater value than achievement with every facility granted? Is not the man who can do much with little better than the man who must have much in order to do at all?

I am perfectly aware that the easy-chair type of university man will sneer at such a proposal, but I feel sure that there is truth in my contention. I know some one will say that proper research can not be done with poor equipment. Much of the finest research ever done in any and every line has been done with poor equipment and such things might happen again. The man with poor equipment sometimes makes up in resourcefulness for far more than the fine equipment that another may have. Then too there are many problems yet to be solved which do not demand expensive or elaborate equipment.

I also anticipate the objection that standards would be hard to fix or sustain for such recognition as I have suggested. The results could scarcely be worse than they are for the doctor's degree. I know one state superintendent of public instruction who flourishes a Ph.D. without ever doing any graduate work. In another case a man boasts of the way in which he manipulated credits through two of our best known universities so as to get the degree in two years. In two cases I have heard about the thesis for the degree was repudiated by the department in which the work was done almost as soon as published. A national council would certainly do no worse than this.

So far as I am personally concerned I am determined to go on with such research as I can whether I get any sort of recognition or not, but my own situation has made me think deeply on the matter and I have finally concluded that something could be done to at least encourage isolated workers if scientific leaders cared to do so.

W. E. Allen
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SCIENCE IN THE SERVICE OF THE NATION

The suggestion contained in *The Scientific Monthly* for September, 1916 (p. 310), that the National Research Council's proposal to help "render the United States independent of foreign sources of supply liable to be affected by war," but failure to propose anything looking toward the cooperation of our nation with other nations in producing supplies, might not meet the approval of all scientific men, is well taken.

That science is in for a period of criticism, even condemnation, because of the part it is playing in the modern war game is indicated by mutterings to this effect heard in diverse quarters. How is the charge to be met?

The mere pointing to what science can do through medicine and other instrumentalities to relieve somewhat the horrors and destruction of war, is clearly not enough. Something more than repair work is needed.

So universal and impersonal are the principles and methods with which science works,

and so fundamental to it are correlation and cooperation, it does seem that among its proposals of service the National Academy of Sciences might include something looking toward the improvement of international relations.

For instance, has science nothing to contribute to the supreme international problem of the day, that of the use of the high seas? And can science suggest no way of utilizing its riches of anthropological and psychological knowledge through governmental channels to help toward a better understanding among peoples of different nations and races?

Lack of sympathetic knowledge on the part of citizens of one country about those of other countries is undoubtedly one of the fertile sources of international friction and hatred; and since a nation must have a large measure of responsibility for its nationals while sojourning in foreign lands, it seems only reasonable that it should make some effort to prevent its citizens, especially those engaged in international trade, from needlessly imperiling its good relationships with other nations.

Since such knowledge is so largely involved in ethical science which in turn is inseparable from physical and cultural anthropology and comparative psychology, it would seem eminently proper that a National Research Council created at the request of the President of the United States falls short of recognizing its full possibilities if it has nothing to propose touching these vital aspects of the national life.

Wm. E. Ritter

The Scripps Institution for Biological Research of the University of California,
September 22, 1916

QUOTATIONS

SCIENCE AND INDUSTRY

On July 28, 1915, an Order in Council constituted two new bodies—a "Committee of the Privy Council for Scientific and Industrial Research," of which Lord Crewe (as Lord President) is chairman, and an advisory council, consisting of eight very eminent men of science under the chairmanship of Sir William McCormick. The first annual report of each of these bodies is now published, and that of the latter, signed by Sir William McCormick, is a document of considerable length and importance. He and his scientific colleagues have made a serious attempt to gauge the extent of our deficiency, both in the volume of scientific research which is being conducted in this country and in its correlation to the needs of industry. In reviewing the question they recognize that the distinction between "pure" and "applied" science is, in a sense, a false one. They point out that all the important advances which recent generations have made in industrial science, from wireless telegraphy to synthetic indigo, have been the direct outcome of discoveries made by "pure" science conducting research solely for its own sake. At the same time they have temporarily concentrated their first attention upon "research of directly industrial application," both for reasons of industrial urgency and because the universities, which are the natural homes of research in pure science, have been so depleted both of students and of teachers by the war, that "they are barely able to continue their routine work, and can command at the moment neither the leisure nor the detachment of spirit that are essential conditions of original research."

Within this narrower field their first step was to save from actual or imminent abandonment a number of researches which were being conducted or directed by professional associations in the period preceding the war. These have been kept going by a series of government grants, and in one case by getting the War Office to release the investigator from military duties. The next step was to hold conferences with the various professional societies and trade associations. These showed that in the main it is the most highly organized industries that have made most use of scientific research, and are therefore most ready for, though perhaps not most in need of, encouragement to make more. Thus "the engineering trades, with their attendant group of distinguished professional societies, have

long been alive to the need and value of scientific research; while the chemical trades for the most part are so divided and individual in outlook that the various professional societies have had neither the influence nor the means necessary to enable them to take any large share in promoting research in connection with those industries." Simultaneously the council undertook a very important project—the formation of a register of all researches actually being conducted on the outbreak of the war. They have also been busy in forming standing committees to advise them on special subjects. One on metallurgy, one on mining, and one on engineering have been set up, with sub-sections of each; and others are in contemplation. The question of aid to research in educational institutions is likewise engaging them. It will thus be seen that they have broken a good deal of ground during the year. But their main task is still ahead; and on this they make some careful observations.

There are two aspects of it—on the one hand, the sheer deficiency of scientific research and training in the country, and on the other, the failure of manufacturers to appreciate the conditions under which science can help them. The first is to some extent a quantitative matter, upon which an increase of endowments can do a great deal. The second is very intricate, since there is no problem of industrial structure—whether the relation of firms to other firms, or that of firms to their employees—which has not its bearing upon it. The council point out that a state of things, under which a number of relatively small firms in a country are more bent on cutting each other's throats than on promoting the success of the national industry against organized foreign competition, can rarely if ever be conducive to scientific advance in an industry. A certain amount of willingness to pool researches and results is almost indispensable to such an advance; and the more there is, the more advance can be hoped for. Quoting a famous American example the council distinguish three sorts of laboratories which a trade requires: (1) An ordinary works laboratory, such as a firm needs for routine tests and controls; (2) an "efficiency" laboratory, studying improvements in products and processes; (3) a laboratory devoted to more fundamental research, whose fruit is less immediate, though over long periods it will prove supremely important. Only a very large firm or else a combination of firms can be expected to undertake all three; and thus the future of industrial science is very closely linked to that of industrial combination. Another factor upon which the council lay hardly less stress is that of solidarity between firms and their employees, such as only a thoroughly generous and enlightened treatment of the employees can secure. It is not an accident that the firms which have been most conspicuous in the world for their scientific advances—such as the Carl Zeiss firm of Jena—have also been most conspicuous for enlightened and generous conditions of employment. The connection between "welfare work" and a more scientific industry is close and vital.—*The London Daily Chronicle.*

SCIENTIFIC BOOKS

The Turquoise. A Study of its History, Mineralogy, Geology, Ethnology, Archæology, Mythology, Folklore and Technology. By JOSEPH E. POGUE, Ph.D. Third Memoir, Vol. XII., National Academy of Sciences, Washington, D. C., 1915. Pp. 162. 22 plts. 4to.

While not ranking in intrinsic value with the precious stones *par excellence,* diamond, ruby, sapphire and emerald, no gem-material has longer enjoyed favor for personal ornament than the beautiful turquoise. Three thousand years before the beginning of our era, the Egyptians adorned their jewels with turquoise from the mines of the Sinai Peninsula, from very ancient times the famous Persian deposits at Nishapur have yielded material of the finest quality to the Orient, and in our own land, for the aborigines of the southwest and for the Aztecs of Mexico, the turquoise was at once a gem of exceptional beauty and one to which they attributed talismanic powers.

Hence it is that no more attractive subject for a monograph can well be imagined than the history and study of the turquoise, and

specialists as well as general readers are to be congratulated that this subject has now been adequately treated in all its manifold aspects by one so thoroughly qualified for the task as Dr. Joseph E. Pogue. The writer has disposed his material very systematically and logically. The first chapter (pp. 9–22) is devoted to the history of the stone and embraces a series of citations from early writers, both classical and Oriental, in chronological order. This is followed by a short chapter on the mineralogy of the stone (pp. 23–27). The localities where turquoise has been found are enumerated and fully described in the next chapter (pp. 28–59). To the geological side of the subject is devoted the fifth chapter, on the origin of turquoise. The four remaining chapters deal, respectively, with the use of turquoise (pp. 68–104), the chalchihuitl question (pp. 105–109), the mythology and folklore of turquoise (pp. 110–128), and the technology of turquoise (pp. 129–136). There is also a very copious bibliography, embracing over a thousand titles (pp. 137–154), and an excellent index (pp. 155–161).

The turquoise mines of the Sinai Peninsula, the oldest in the world, were worked from about the time of the I. Dynasty (about 4500 B.C.)[1] to the reign of Rameses VI. (1161–1156 B.C.), since which time turquoise does not appear to have been much used in ancient Egypt. The ancient mines in the Wady Maghara were rediscovered in 1845 by Major MacDonald, a British cavalry officer. The Egyptian name may have been *Mafek* or *Mafkat,* although this word appears rather to have designated malachite and other green stones. The writer of the present notice has conjectured that the *shoham* stones of the breastplate and on the shoulders of the Hebrew high priest may have been turquoises.[2] Strange to say a similar uncertainty hangs over the question whether Pliny's *callaina* means malachite or turquoise. Here again, although Pliny apparently wishes to describe a green stone, the word or a variant (also used by Pliny) *callais* came to mean the stone later called turquoise. A very probable conjecture accepted by Dr. Berthold Laufer, is that Pliny's sky-blue jasper (jaspis aerizusa) is the turquoise.[3] As an aid to the study of the early mentions Dr. Pogue has given a great number of passages referring to the turquoise, from classical and Oriental writers, in translation, although we must bear in mind that in some cases the English rendering "turquoise" is not certainly the meaning of the foreign original. The earliest use of this name, signifying that the stone was brought by way of Turkey to western Europe, is in the Latin gem-treatise of Arnoldus Saxo, written in the early part of the thirteenth century.

In the New World, among the Aztecs, the name *chalchihuitl* seems to have been applied to both green and blue stones, as with the other designations we have noted, and undoubtedly some chalchihuitls were turquoises. Of its use in decoration by the ancient Mexicans, certain curious masks, inlaid with this stone, offer incontrovertible evidence. The finest of these are in the Christy Collection of the British Museum (see Plate 15 of Dr. Pogue's book). Full descriptions are also given of typical turquoise-incrusted or decorated ornamental objects and jewelry made in later times by the Pueblo Indians and by the Navajos of Arizona and New Mexico.

The details as to turquoise mining in our day at the old Nishapur deposits are very interesting and valuable (pp. 37–39). The output is carefully classified into three categories, the first-class material, being called *Angushtari,* literally, "ring stones"; large pieces of this have brought as much as $1,500, and pieces no

1 The uncertainty as to the exact initial date of the I. Dynasty is shown by the difference in the figures given by leading Egyptologists. The latest date is that of Lepsius, 3892 B.C. Then come Brugsch Bey with 4400 B.C., Flinders Petrie with 4777 B.C., and Mariette with 5004 B.C. Champollion, the father of Egyptology, even gave 5867 B.C., as the opening date. Brugsch Bey states that turquoise was already mined in Egypt in 4000 B.C., during the III. Dynasty, at the time of King Snefru, and that mining was not carried on later than the reign of Rameses II., 1300 B.C.

2 George Frederick Kunz, "Curious Lore of Precious Stones," Philadelphia and London, 1913, p. 299.

3 Pogue's "The Turquois," p. 11.

larger than a pea may be worth $40. Each stone is separately and accurately appraised. The second-class material, *Barkhaneh*, is sold by weight, bringing at the mines from $25 a pound for the poorer quality, up to $450 for the best quality. The third class, *Arabi*, is only utilized in Asia, for inlaying, incrustation, and so forth, a lot of twelve pounds once bringing only $300. In the United States a mine in the Cerrillos district, New Mexico, is believed to have produced more fine turquoises than any other deposit, the finest specimens being only equalled by some from the Burro Mountains in the same state, and from Nevada.

Within the narrow limits of this notice we can only touch upon a few points suggesting the wealth of carefully selected and excellently arranged material that Dr. Pogue has so indefatigably assembled here. For ethnologists and students of folklore, the chapter on the mythologic and talismanic fancies connected with this "celestial stone" among many different peoples, will prove especially interesting and instructive. The many plates are well selected to illustrate the subject and are clearly and effectively printed.

Certainly no one who acquires this book will fail to find it all, or more than all, that he expected, and we think that the thanks of those interested in the subject are due to the National Academy of Sciences and to the scholarly author, for having thus enriched our precious-stone literature.

It is very rarely that all the citations relating to a given subject are quoted in extenso, giving the exact and full reference. To the student and scientific worker this is of inestimable value, because frequently when only partial quotations are made, and the references are even inaccurate, much time is consumed in searching for an item which it is almost impossible to locate. What a great assistance it is, particularly to delvers in scientific fields, when, without loss of time in going from one library to another, all the data on a certain subject are found under one cover and immediately at hand. This has been made possible through the far-sighted policy of the National Academy of Sciences, and is especially exemplified in their publication, Volume 13, a catalogue of the Meteorites of North America, dated January 1, 1909, by Oliver Cummings Farrington. These two memoirs, in the presentation of their rich references with the deductions of experienced workers, are noteworthy contributions to two subjects, than which there is probably none of greater interest to the archeologist, petrologist, chemist, student and general worker.

GEORGE F. KUNZ

The Mythology of All Races. In thirteen volumes. *North American*. By HARTLEY BURR ALEXANDER, Ph.D., Professor of Philosophy, University of Nebraska. Volume X. Marshall Jones Company, Boston, Mass. 1916. Pp. 325, 23 full page and 2 text illustrations, linguistic map, 45 pp. Notes, 11 pp. Bibliography, authorities used.

Volume X. is one of the two volumes recently published of a series, the purpose of which, as stated by the editor, Dr. Louis Herbert Gray (Vol. I., p. xii), is to assemble "into a single unit" the mythologies of all races and "since the series is an organic unit—not a chance collection of monographs—the mythology of an individual race is seen to form a coherent part of mythology."

With this plan before him, Professor Alexander in Volume X. has not presented a collection of mythic stories drawn from a continent of varied aspects and conditions, but has aimed to show, as far as present knowledge will permit, the contribution that North America can offer to a world study of mythology. In the preface, he says of his subject: "The literature, already very great, is being augmented at a rate hitherto unequaled, and it is needless to say that this fact alone renders any general analysis at present provisional. As far as possible the author has endeavored to confine himself to a descriptive study and to base this study upon regional divisions."

The territory and the peoples of America north of Mexico he divides into seven regions: (1) The Far North, (2) The Forest Tribes, (3) The Gulf Region, (4) The Great Plains, (5) Mountain and Desert, (6) The Pueblo

Dwellers, (7) The Pacific Coast. A general scheme is followed in the treatment of these seven divisions. The tribes dwelling within a division are named; the environment indicated; cosmogony outlined; the deified powers and mythic characters mentioned; and the beliefs, legends, stories, briefly set forth. By such a broad sketch of each, the seven divisions are presented in the eleven chapters of the book.

Professor Alexander in his "Introduction," remarks (p. xv):

"Mythology in the classical acceptation can scarcely be said to exist in North America; but in quite another sense—a belief in more or less personified nature-powers and the possession of stories narrating the deeds and adventures of these persons—the Indians own, not one but many mythologies; for every tribe and often within the tribe, each clan and society, has its individual mythic lore." This statement he qualifies and adds the following discriminating observation. "Beliefs vary from tribe to tribe, even from clan to clan, yet there are fundamental similarities and uniformities that afford a basis for a kind of critical reconstruction of a North American mythology. No single tribe and no group of tribes has completely expressed this mythology—much less has any realized its form; but the student of Indian lore can scarcely fail to become conscious of a coherent system of myths, of which the Indians themselves might have become aware in the course of time, if the intervention of Old-Word ideas had not confused them." On p. xvi the author wisely says: "In America, no more than in the Old World, are we to identify religion with mythology. The two are intimately related; every mythology is in some degree an effort to define a religion." Attention is called to the fact that "the powers which evoke the Indian's deepest veneration are of rare appearance in the tales," and adds: "The Indian's religion must be studied in his rites rather than in his myths." On p. xviii we read: "Inevitably these powers (of nature) find a fluctuating representation in the varying imagery of myth. Consistency is not demanded, for the Indian's mode of thought is too deeply symbolic for him to regard his own stories as literal; they are neither allegory nor history; they are myth with a truth midway between that of allegory and that of history. . . . The vast majority (of Indian stories) are obviously told for entertainment; they represent an art, the art of fiction; and they fall into the classes of fiction, satire and humor, romance, adventure. Again, not a few are moral allegories, or they are fables with obvious lessons. . . . Myths that detail causes are science in infancy and they are perhaps the only stories that may properly be called myths."

Space forbids further quotation of the many discerning observations or deductions scattered throughout the pages.

One who knows something of the vast jumble of material that in this volume has been whipped into shape, can best appreciate the difficulty of the task essayed by the author and it is a pleasure to call attention to the breadth of culture and sympathy he has brought to its accomplishment. "The time will certainly come for a closely analytical comparative study of North American myths" he declares; and when that time arrives, may the task fall into equally competent hands, as the present volume.

This interesting and valuable book was not prepared for specialists, although it will be of service to such. To the general student of American history it presents a new and comprehensive view of ancient life and thought upon this continent.

Alice C. Fletcher

NOTES ON CANADIAN STRATIGRAPHY AND PALEONTOLOGY

CORDILLERAN PROVINCE

The Rossland, British Columbia, mining camp is situated in the Columbia Range immediately north of the international boundary and west of the Columbia River. A recently published memoir by C. W. Drysdale,[1] al-

[1] "Geology and Ore Deposits of Rossland, B. C.," C. W. Drysdale, Geological Survey, Canada, Memoir 77, 1915.

though devoted in the main to a description of the ore deposits, gives much valuable information concerning the stratigraphy and geological history of the region. The oldest rocks are the slates, shales, quartzites, calcareous sediments, and tuffs of the Mt. Roberts formation, aggregating over 1,200 feet in thickness. A meager collection of fossils, collected by R. W. Brock and identified by H. M. Ami, indicates the Pennsylvanian age of the formation, but gives no clue to faunal relationships. The sediments are cut by intrusive and extrusive volcanic rocks of Triassic and Jurassic age; the whole region suffered orogenic uplift at the close of the last-named period. By the end of Cretaceous times it had been peneplained and was again deformed during the Laramide revolution. Stream gravels, probably of Eocene age, are known in two localities, but the major record of mid-Tertiary time is one of volcanic activity. By the close of the Pliocene period, a late mature topography of comparatively slight relief had been carved beneath the Cretaceous paleoplain and at that time the streams were rejuvenated by another epirogenic uplift. The greater part of the present relief is the result of Quaternary stream erosion aided by glaciation.

The agricultural development of the Prairie Provinces of Canada must inevitably bring an increasing demand for phosphates, although at the present time no deposits of mineral phosphate are being worked in the Dominion. In the hope that phosphate beds similar to those of the western United States might be discovered in Alberta and British Columbia, the Canadian Conservation Commission delegated F. D. Adams and W. J. Dick to make a reconnaissance of favorable localities during the 1915 field season. The report[2] of their work was published late in 1915—an enviable record for prompt publication by a government scientific bureau. Three lines of section across the Rocky Mountains were selected as possibly exposing strata similar to the phosphate-bearing Pennsylvanian terranes of Idaho and Montana. Relying solely upon paleontological evidence, it was speedily ascertained that two of these contained no rocks of Upper Carboniferous age and attention was centered upon the third area, the Rocky Mountains Park at Banff. By faunal analogy with the Montana field, 350 miles to the south, phosphate beds might be expected to occur near the contact of the Upper Banff limestone and the Rocky Mountain quartzite. Search was rewarded by the discovery of low-grade phosphate rock in place and one piece of high-grade "float," enough to demonstrate that careful prospecting in these horizons is justifiable. The report is concluded with a number of valuable suggestions for prospectors and a summary of the phosphate resources of the world.

Recent field work carried on in the Canadian Rockies by L. D. Burling[3] has resulted in important additions to our knowledge of Paleozoic stratigraphy in that region. The ammonite-bearing shales near Massive, west of Banff, Alberta, originally described as of Jurassic age[4] are now known to represent the Upper Banff shales, are probably of Permian age, and occupy the normal position above the Rocky Mountain quartzite. Devonian and Cambrian strata are in juxtaposition over an area of 5,000 square miles between Banff and Elko, British Columbia, although only a few miles to the northwest 10,000 feet of Ordovician and Silurian strata overly the Cambrian. The Albertella fauna is of especial interest because it is the oldest Cambrian fauna found in contact with the Beltian rocks of Montana and adjacent regions. It is now known to be of early Middle Cambrian age from its discovery in strata in Mount Bosworth, British Columbia, and elsewhere. The line between the Middle and Upper Cambrian was found over wide areas to be the locus of a pronounced emergence of the sea bottom,

[2] "Discovery of Phosphate of Lime in the Rocky Mountains," F. D. Adams and W. J. Dick, Commission of Conservation, Canada, Ottawa, 1915.

[3] "Notes on the Stratigraphy of the Rocky Mountains, Alberta and British Columbia," L. D. Burling, Geological Survey, Canada, Summary Report for 1915, 1916, pp. 97–100.

[4] Geological Survey, Canada, Guide Book 8, Pt. 2, 1913, p. 191.

while the Lower and Middle Cambrian are separated by a diastrophic break of considerable magnitude.

ORDOVICIAN FORMATIONS AND FAUNAS

Nearly half of the iron smelted in Canada is obtained from the Wabana iron ore deposits on Bell Island in Conception Bay, Newfoundland. Dr. A. O. Hayes, in a recently published memoir,[5] has given an excellent description of these ores and their occurrence. Oolitic iron ore with ferruginous shales and sandstones forms part of a sedimentary series containing a fauna which correlates with the Arenig and lower Llandeilo stages of Wales, corresponding roughly to the Beekmantown, Chazy, and Black River of the Appalachian province. The spherules of ore are composed of alternating concentric layers of hematite and chamosite (a green iron silicate) and in many cases were pierced by living boring algæ. Algæ are found in all horizons in the ore beds and doubtless played an important part in the precipitation of these primary bedded ores. Practically all of the calcium and phosphorus of the ores is derived from linguloid brachiopod shells. Layers of oolitic pyrite associated with a graptolite fauna occur in the midst of the shales between two of the iron ore zones. These are interpreted as indicative of open ocean currents and deeper water. The chapters treating of the origin of these beds make use of many data obtained from recent studies of Drew, Doss, and others, concerning the chemical reactions induced by marine bacteria.

Epicontinental seas of Ordovician time were much more basin-like in character than was formerly supposed. Difficulties have frequently arisen from the fact that minor formation names were carried over wide expanses of territory without due examination of fossil faunas. Especially is this true of the strata deposited during the latter part of the period. Faunal studies by A. F. Foerste, now in progress, are yielding very important results concerning the so-called Lorraine and Richmond terranes of Ontario and Quebec.[6] The investigations embrace two general areas: that extending from the northern shore of Lake Ontario northwestward across Georgian Bay, and that east of the Frontenac axis in eastern Ontario and southern Quebec.

The faunas of the "Lorraine" formations in the more westerly of these two basins are so different from the typical Lorraine fauna of New York that the use of the term Lorraine can be of little value. The terms Maysville and Eden may prove much more appropriate, as these strata can probably be correlated with the formations so named in the vicinity of Cincinnati, Ohio, at least in a general way. Apparently the "Lorraine" of Ontario presents much more in common with the strata of a similar age in the Ohio basin than with the Lorraine of the province of Quebec. The latter is, also, faunally distinct from the New York Lorraine and evidently represents sedimentation in a somewhat isolated basin. Quite probably the Frontenac axis was sufficiently developed in later Ordovician time to form a faunal barrier along the southern and western border of the region in which accumulation of the Quebec Lorraine was being effected.

In neither of the Canadian provinces is there a definite line of demarcation between the "Lorraine" and Richmond. The Richmond fauna seems to have invaded the "Lorraine" seas gradually, a few species at a time, rather than *en masse*. The upper part of the so-called Lorraine of Ontario is doubtless of Richmond age. The Richmond includes also the Queenston shales, largely of a red color, which occur in eastern Ontario and Quebec as well as in the vicinity of Lake Ontario. These shales appear to be merely the estuarine representatives, along the southern margin of the Laurentian highlands, of marine strata elsewhere known as the Richmond formation. The Richmond fauna of the eastern basin has a decidedly western aspect and embraces only

[5] "Wabana Iron Ore of Newfoundland," A. O. Hayes, Geological Survey, Canada, Memoir 78, 1915.

[6] "Upper Ordovician Formations in Ontario and Quebec," A. F. Foerste, Geological Survey, Canada, Memoir 83, 1916.

a small element closely akin to the Richmondian of Anticosti Island. It is probable, however, that for a brief time open waterways afforded migration by way of some northern passage from Anticosti as far west as Manitoulin Island in Georgian Bay, for a small contingent in the Richmond fauna of the western basin seems to have been recruited from the St. Lawrence gulf.

OIL AND GAS FIELDS

Brief descriptions of the Paleozoic strata of southern Ontario and Quebec are included in a treatise upon the oil and gas fields of these provinces by Wyatt Malcolm.[7] All available drill records together with statistics of production are assembled and the occurrence of oil and gas with relation to rock structure is discussed. The oil production has steadily declined in recent years, but gas production has been rapidly increasing and the fields have been widely extended. Oil or gas, or both, have been found in the Onondaga, Salina, Guelph, Clinton, and Medina formations. The prospects for new fields are not very encouraging.

Similar summary descriptions of Paleozoic strata and the logs of wells drilled for oil and gas in Ontario are assembled by C. W. Knight[8] in the current report of the Ontario Bureau of Mines.

DEVONIAN FORMATIONS AND FAUNAS

In general, the introduction of a new fauna or faunal facies is of more importance in delineating stratigraphic boundaries than is the persistence of an old biota. Applying this principle to the basal Devonian strata in Ontario, it becomes necessary to place the Detroit River series in the Devonian rather than in the Silurian system. The evidence for this conclusion is presented by C. R. Stauffer in a paper[9] which may be considered as a postscript to the same author's memoir on the Devonian of Ontario.[10] The Detroit River, or Upper Monroe, series comprises four formations: the Lucas and Amherstburg dolomites, the Anderdon limestone, and the Flat Rock dolomite, named in descending order. The Amherstburg fauna is typically Devonian with strong Onondaga affinities, but the Lucas dolomite contains a large proportion of residual Silurian forms, many of which display little or no recognizable variation from their pre-Devonian ancestors. The erosion interval between the deposition of the Detroit River series and the overlying Onondaga limestone was a long one, so that the former is probably to be referred to the Helderbergian. The faunas are, however, so distinctive that they must have existed in an embayment, presumably from the north or northwest, which was altogether isolated from that of New York and adjacent states toward the east and south.

The Gaspé peninsula in Quebec rivals Anticosti Island in the significance of its record of mid-Paleozoic times. Not the least interesting of its sections is that of the escarpment of the Table-À-Rolante at Percé, which extends northwestward and southeastward from the Pic d'Aurore. John M. Clarke's description[11] of this exposure is artistically illustrated by a colored reproduction of the brilliant cliffs which overhang the Mal-Baie. The summit of the cliffs consists of horizontal strata of Bonaventure conglomerate, a typical "Old Red" sandstone of later Devonian, and possibly in part Mississippian, age. Unconformably underlying that formation are the Percé limestone and the Pic d'Aurore series. In the midst of the latter is a sandstone band carrying the typical sand fauna of the New York Oriskany. Faulted up at the east is a block of Barré limestone, of earliest Devonian age. Beneath the Devonian strata are highly contorted Silurian and Ordovician sediments. The shoal water Oriskany sands form a striking contrast to the lower portion

[7] "The Oil and Gas Fields of Ontario and Quebec," Wyatt Malcolm, Geological Survey, Canada, Memoir 81, 1915.

[8] "Oil and Gas in Ontario," C. W. Knight, Ontario Bureau Mines, 24th Ann. Rept., Pt. 2, 1915.

[9] *Bull. Geol. Soc. America*, Vol. 27, 1916, pp. 72–77.

[10] Geol. Surv., Canada, Memoir 34, 1915.

[11] N. Y. State Museum, Bull. 177, 1915, pp. 147–153.

of the Grande Grève limestone, which outcrops elsewhere on the peninsula and carries a similar Oriskany fauna of overgrown sand-loving invertebrates imprisoned in a calcareous matrix. As in New York, both the shallow and deep water facies of the Oriskany are present at Gaspé, but without the striking differences in faunal content. The Bonaventure conglomerate, in its lithology as well as in its structural relations to the underlying formations, bears testimony to the importance of the mid-Devonian orogeny in the north-eastern Appalachian province. Dr. Clarke in another paper[12] in the same publication lays stress upon this diastrophy and couples with it the volcanic activity responsible for the Monteregian hills.

TRIASSIC FORMATIONS

Detailed descriptions of the Newark series, as exposed along the shores of Minas Basin and the Bay of Fundy, are given by Sidney Powers in an important contribution concerning the Acadian Triassic.[13] The area is the most northerly of the geo-synclinal basins developed in the Atlantic coastal province during the Triassic period and presents problems similar to those of the Connecticut Valley. Sedimentation was largely fluviatile, in the main resulting from the occasional floods of a hot dry climate. Fissure eruptions and volcanic ejections occurred at intervals during the accumulation of the sediments.

PLEISTOCENE (?) MAN IN BRITISH COLUMBIA

Fragments of a human skeleton were discovered in 1911 near Savona, B. C., in silt beds alleged to be of Pleistocene age. A claim of great antiquity for the skeleton was made before the Royal Society of Canada in May, 1915. The bones are those of an aged woman and display no characters that would distinguish them from those of a modern Shuswap Indian.[14] An investigation of the deposits from which the bones were obtained was undertaken by C. W. Drysdale. He reports[15] that the field evidence indicates the Recent age of the silts at the locality. There is, therefore, no basis for the belief that the Savona skeleton is a relic of Pleistocene man.

KIRTLEY F. MATHER

QUEEN'S UNIVERSITY,
KINGSTON, CANADA,
September 7, 1916

[12] N. Y. State Museum, Bull. 177, 1915, pp. 115–134.

[13] *Jour. Geol.*, Vol. 24, Nos. 1, 2 and 3, 1916.

[14] Knowles, F. H. S., Geol. Surv., Canada, Summary Report for 1915, 1916, pp. 281–283.

[15] "Human Skeleton from Silt Bed near Savona, B. C.," C. W. Drysdale, Geological Survey, Canada, Summary Report for 1915, 1916, pp. 91–92.

METHODS OF CRITICISM OF "SOIL BACTERIA AND PHOSPHATES"[1]

A CIRCULAR letter, dated July 28, 1916, criticizing Bulletin 190 ("Soil Bacteria and Phosphates") of the University of Illinois Agricultural Experiment Station was sent to many editors of agricultural journals. This letter bears the signature of Dr. H. J. Wheeler, of the Agricultural Service Bureau of the American Agricultural Chemical Company.

The caption employed is as follows: "Confidential and Not For Publication." This will doubtless appear to those who welcome frank and open criticism as an entirely unwarranted and a highly undignified manner of criticism. No copy of this letter was received by us from Dr. Wheeler, but through the courtesy of the agricultural press the matter has reached us from many sources and from several different states.

The purpose of Dr. Wheeler's letter to the agricultural editors is evidently to belittle the importance of the discovery that the nitrifying bacteria have power to make rock phosphate soluble.

As space will not permit quoting in full the contents of this four-page letter, we quote only the statements under discussion. In the last paragraph of the first page, we read:

> The organic acids and the carbonic acid produced in the decomposition of vegetable matter or brought

[1] SCIENCE, p. 246, August 18, 1916, and Bulletin 190, University of Illinois Agricultural Experiment Station.

down in the rainfall, including also nitrous and nitric acid, produced as described above, tend to unite in the soil with the most readily attackable bases in the basic silicates and with the lime of the carbonate of lime before they can attack raw rock phosphate effectively.

That the acids attack the basic silicates is agreed, and this means that some of the potash minerals naturally contained in the soil are thus rendered soluble, and the potassium contained in them made available to higher plants. Potash minerals are important and abundant constituents of all normal soils. The idea conveyed by this part of the quoted statement is in agreement with the published results of the Illinois Experiment Station[2] and was sufficiently considered by the authors of Bulletin 190, as the following quotation indicates:

The nitrous acid produced may act upon compounds of iron, aluminum, potassium, sodium or magnesium which occur in soils or it may act upon tricalcium phosphate, calcium silicate or calcium carbonate, if present.

To intimate, as Wheeler does, that the acids will choose to unite first with these basic silicates before attacking effectively the raw rock phosphate, is not in accord with the scientific facts, nor does it appear to be sound chemical reasoning, and no mention is made by Wheeler of the acid silicates contained in the soil which may react with raw rock phosphate. To establish minute acid and alkaline areas in the soil is to approach the ideal for both the biological and chemical factors to work in unison in liberating insoluble materials. Ground limestone made up of various degrees of fineness actually provides alkaline areas, and fermentations of organic residues are always developing acid areas. As raw rock phosphate is dissolved by acids, whether produced by bacteria or by chemical means, and, as it is so placed that some of it must have contact with the fermenting areas, it is not difficult to understand why it becomes soluble and why it produces increased crop yields, even though at many other points in the soil centers of alkalinity exist.

The tricalcium phosphate used by us is commented upon by Dr. Wheeler as "an especially soluble artificial tricalcium phosphate." If tricalcium phosphate was a soluble material, which of course it is not, there would have been no logical reason for conducting the experiments.

The "high temperature" of the experiment is mentioned by Wheeler, and, although of minor importance, we note from the records that during the seventy-eight days from July 4 to September 18, 1916, there were sixty-one days on which the temperature of the air ranged above that of the experimental laboratory. At best, temperature could only influence the rate of biochemical action in this experiment.

In regard to the statements bearing on the extent of this solvent action of nitrite bacteria in soils, it is necessary to quote in part the last paragraph of Wheeler's letter.

In their hope of confining the solvent action of the nitrous acid as fully as possible to the raw rock phosphate, Hopkins has recommended that the phosphate be turned under in intimate contact with organic matter, yet when one realizes the even closer contact of the many soil particles with the organic matter at the same time, it will be obviously impossible for the nitrous acid to attack wholly or even chiefly the raw rock phosphate.

In the table below taken from Illinois Bulletin 190 are presented the amounts of phosphorus, calcium, and nitrogen required by standard crops, and the amounts of phosphorus and calcium which would be made soluble if all the nitrogen required for the crop should be oxidized to nitrate and should act upon pure rock phosphate.

The figures show that there is possible of solution from this biochemical process about 7 times as much phosphorus as corn, wheat, or oats require, and 9 times as much as timothy requires. Greater differences occur in the calcium figures, there being possible of solution 14 times that required for corn, 18 times that required for wheat, 12 times that required for oats, and 8 times that required for timothy.

Nowhere in Dr. Wheeler's letter has he pointed out that the nitrous acid furnishes

[2] Bulletin 182, "Potassium from the Soil."

from seven to nine times the necessary solvent power.

PHOSPHORUS, CALCIUM AND NITROGEN REQUIRED BY CROPS, COMPARED WITH THAT POSSIBLE OF SOLUTION WHEN NITRITE BACTERIA ACT UPON TRICALCIUM PHOSPHATE

(Expressed in pounds)

Crop	Nitrogen	Phosphorus		Calcium	
	Required	Required	Possible.	Required	Possible
Corn: Grain, 100 bu.. Stover, 3 tons. Cobs, ½ ton...	150	23	166	22	321
Wheat: Grain, 50 bu... Straw, 2½ tons.	96	16	107	11	206
Oats: Grain, 100 bu.. Straw, 2½ tons.	97	16	108	17	208
Timothy, 3 tons.	76	9	84	20	163

The authors desire to point out that the figures in the table were based upon the solvent action which only the nitrogen would exert when it is oxidized. The associated acid radicle as stated on page 402 of the bulletin may make equal amounts of phosphorus and calcium soluble, thus doubling that reported above. Thus, corn, wheat and oats only require one fourteenth of the phosphorus possible of solution when the acid formed by the nitrite bacteria and that which was combined with the oxidizable ammonia both act upon the raw rock phosphate. It may be that the phosphorus would be made available even if only converted to the dicalcium form, which would require only half as much acid.

The recent results of the New Jersey Station on the oxidation of sulfur and its solvent action on raw rock phosphate in soils support the statement that phosphorus is made soluble by biochemical oxidation in large amounts even in the near presence of other bases.[3]

Limited space is taken to include some field data from the large mass available, showing the advantage of rational systems of permanent soil enrichment in crop rotation, in which raw rock phosphate, limestone and "home-grown" organic matter are the only materials used.

WHEAT YIELDS PER ACRE: FOUR-YEAR AVERAGE UNIVERSITY OF ILLINOIS FARM

Soil Treatment	Bushels
Crop residues	27.6
Manure	28.8
Crop residues, phosphorus	42.0
Manure, phosphorus	45.6
Crop residues, phosphorus, limestone	46.8
Manure, phosphorus, limestone	48.9

These figures demonstrate sufficiently the advantage of mixing organic materials and raw rock phosphate as judged by increased crop yields, and they show that limestone, even when used with raw rock phosphate under field conditions, gives a further increase over that produced by the combination of organic materials and raw rock phosphate.

In his letter, Dr. Wheeler quotes from Director Thorne of the Ohio Agricultural Experiment Station as follows:

Where we have used floats (raw rock phosphate) as a reenforcement of manure on this farm alongside of acid phosphate, the acid phosphate has given us a slightly larger net gain in the average of the 18 years' work, and a decidedly large gain during the last half of the period.

But Wheeler fails to point out that this statement is based upon only one of the two methods used by Director Thorne in computing the increase produced by the phosphates. He might have quoted from Director Thorne's writing as follows:[4]

On Section *C*, Plots 1 and 11, which, it will be observed, are continuous, have regularly given yields so much larger than those of the other unmanured plots of this section as to suggest the possibility that the land covered by these plots may have been at one time occupied by a fence-row, the tract lying near a barn, and for this reason it has been deemed best to calculate the increase on the general average of all the unfertilized plots. By this method of calculation the average increase on Plots 2 and 3 combined (with raw phosphate) is found to be practically the same as on Plots 5 and 6 combined (with acid phosphate) but when the larger cost of the acid phosphate is deducted the net gain is a little greater on Plot 2 and 3.

[3] *Soil Science*, p. 533, June, 1916.

[4] P. 18, Ohio Experiment Station Circular 104.

On page 175 of Director Thorne's excellent book on "Farm Manures," he also shows that, when the increase is computed by the method which he states "has been deemed best," the net profit is greater per acre, and very much greater per dollar invested, from raw rock phosphate than from acid phosphate.

ACRE-YIELDS IN OHIO MANURE-PHOSPHATE EXPERIMENTS: AVERAGE OF 9 YEARS, 1906–1914

Phosphate	None	None	Rock	Rock	Acid	Acid
Manure	Yard	Stall	Yard	Stall	Yard	Stall
Corn, bushels	54.4	62.7	68.3	72.1	65.8	68.9
Wheat, bushels	24.3	25.5	27.2	28.2	29.8	29.4
Hay, tons	2.00	2.34	2.43	2.60	2.43	2.68
Value 3 crops	$57.20	$65.20	$68.52	$72.20	$69.60	$72.52
Phosphate gains	......	......	11.32	7.00	12.40	7.32
Phosphate cost	......	......	1.20	1.20	2.40	2.40
Phosphate profit	......	......	10.12	5.80	10.00	4.92
Profit per $1	......	......	8.43	4.83	4.17	2.05

The accompanying table gives the average of the actual yields secured in these Ohio experiments during the last half of the eighteen-year period.

If we value the corn at 40 cents a bushel, the wheat at 80 cents, and the hay at $8 a ton, and count the cost of rock phosphate at $7.50 per ton and acid phosphate at $15, we find, by this direct method of computation, that the rock phosphate was slightly more profitable per acre, and more than twice as profitable per dollar invested, as the acid phosphate.

In his letter to the agricultural editors, Dr. Wheeler quotes a personal letter from Professor Mooers expressing his opinion as to the conclusions which should be drawn from experimental data, in part unpublished, secured by the Tennessee Experiment Station. If this opinion is based upon a continuation of the experiments in which two crops (wheat followed by cowpeas) were grown every year on the same land, as reported in Tennessee Experiment Station Bulletin No. 90, in which on page 89 it is shown that for each dollar invested rock phosphate paid back $2.29, and steamed bone meal only $1.90, and in which the use of steamed bone meal is commended and the use of rock phosphate discouraged, we must await further publication by the Tennessee Station before accepting Wheeler's confidential report of Mooers' personal opinion.

For more complete data from the phosphate experiments conducted by many state experiment stations, the interested reader is referred to Illinois Experiment Station Circular 186, "Phosphates and Honesty."

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SPECIAL ARTICLES

THE LIGHT-PRODUCING SUBSTANCES, PHOTOGENIN AND PHOTOPHELEIN, OF LUMINOUS ANIMALS

IN a previous issue of SCIENCE (N. S., XLIV., 208, 1916), I called attention to Dubois's discovery of substances called luciferin and luciferase in the West Indian "cucullo" *Pyrophorus noctilucans*, and the mollusc, *Pholas dactylus*. I also recorded the existence of similar bodies in the fire-flies, *Photinus* and *Photuris*, and of luciferin in luminous bacteria. Luciferase, according to Dubois, a thermolabile enzyme capable of accelerating the oxidation of luciferin, is prepared by allowing an extract of luminous cells to stand until the light disappears. The luciferin is thus completely oxidized and used up. The luciferin, according to Dubois, a thermostabile substance capable of oxidation with light production, is prepared by extracting the luminous cells with hot water which destroys the luciferase but not the luciferin. Light will appear if we mix the solutions of luciferin and luciferase in presence of oxygen. Each

substance alone in solution is non-luminous and fairly stable. On this theory, therefore, the luciferin is the source of the light and, according to Dubois, *Pholas* luciferin will give light on oxidation with $KMnO_4$, blood, H_2O_2 and similar oxidizing agents. He found also substances (luciferase) in the blood of various marine molluscs and crustaceans which would give light with *Pholas* luciferin, but the latter he found only in the luminous organs of *Pholas dactylus*.[1]

Since the publication of my previous paper, I have investigated very thoroughly the chemistry of light production in five different forms:[2] the Japanese fire-flies, *Luciola parva* and *L. vitticollis;* an ostracod crustacean, *Cypridina hilgendorfii;* a squid, *Watasenia scintillans;* a pennatulid, *Cavernularia haberi;* and the protozoan, *Noctiluca miliaris. Watasenia, Cavernularia* and *Noctiluca* will not give the luciferin-luciferase reaction despite the most favorable conditions and many attempts to demonstrate it. These organisms need not be considered at present, as there are many reasons why the luciferin-luciferase reaction might fail.

Cypridina and *Luciola* both contain bodies similar to luciferin and luciferase, but in these forms the production of light differs in very essential points from that described by Dubois in *Pholas,* and I have come to quite different conclusions regarding the nature of the substances concerned. We may conveniently use Dubois's terminology for the present. First, in *Cypridina* and *Luciola,* it is the luciferase which is found only in the luminous cells, and luciferin is widely distributed in non-luminous forms. Second, I have been unable to oxidize luciferin with light production by $KMnO_4$ or other oxidizing agents. Third and most important, *Cypridina luciferase* will give light with substances (NaCl crystals, thymol, butyl alcohol, saponin), *some of which could not possibly be oxidized.* The *luciferase* and not the luciferin is therefore the *source* of the light. Instead of luciferin oxidizing with light production through the catalytic action of luciferase, luciferin is a body assisting in the evolution of light from luciferase. I therefore propose the new names of *photogenin* (light producer from *phos,* light, and *gennao,* to produce) for luciferase, and *photophelein* (light assister from *phos,* light, and *opheleo,* to assist) for luciferin, to indicate more clearly the nature of the light-producing process. *Cypridina* photophelein (= luciferin) in addition to its thermostabile property is easily dialyzable, while photogenin (= luciferase) is not. In these points and some others, the system resembles and may be compared to the zymase system (enzyme and coenzyme) of yeast cells.[3] As in so many other biological reactions an easily diffusible thermostabile substance (coenzyme) and a difficultly diffusible thermolabile substance (zymase) are concerned.

The light-producing power of photogenin and photophelein is very extraordinary. *Cypridina* photogenin will give visible light with photophelein in one part to 1,600,000,000 parts water. Even this is an underestimate, as we do not know the concentration of photogenin in the luminous cells apart from proteins, water, etc. In the small amounts necessary to produce light and in destruction by boiling, photogenin resembles an enzyme but differs in the fact that it is used up in the reaction. Experiment has shown that it takes photophelein from one hundred *Cypridinas* to use up the photogenin from one *Cypridina.* Perhaps the fact that photogenin is used up is not sufficient evidence to condemn it as an enzyme since many enzymes are poisoned or destroyed by reaction products; nevertheless I have deemed it best for the present to avoid the termination *ase.*

Cypridina and the firefly differ from *Pholas* in the points enumerated above and agree in most properties with each other, but with some exceptions. For instance, firefly photogenin is readily destroyed by chloroform or

[1] Dubois, R., *Annales de l. Soc. Linn. de Lyon,* 1913 and 1914.

[2] Studies made in Japan under the auspices of the department of marine biology, Carnegie Institution of Washington.

[3] Harden, A., and Young, W. J., *Proc. Roy. Soc., B,* 77, 405, 1906, and 78, 369, 1906.

ether and is a very unstable substance. Firefly photophelein is not harmed by chloroform and can be preserved for many days. On the other hand, it is the *Cypridina* photophelein which is the unstable substance. A water solution of *Cypridina* photogenin preserved with chloroform for 56 days will still give light on mixing with fresh photophelein. It should be borne in mind that photogenin, the source of the light, is not only a very powerful substance, but also a stable substance. If we can see the light from a stable body in a concentration of 1:1,600,000,000, what might not be accomplished with the pure substance? We have, perhaps, in the power of photogenin the first indication of a really possible utility of "cold light." My work is not sufficiently advanced to state the chemical nature of photogenin except to say that it is probably protein. Many of the properties of photogenin and photophelein will be found in forthcoming papers on *Cypridina, Cavernularia* and the firefly.

The photogenin and photophelein of *Cypridina* are secreted together into the sea water as a perfectly clear granule-free secretion from gland cells on the upper lip, but as already mentioned, in the body, photophelein is found throughout the animal, probably in the blood, photogenin only in the luminous cells. Just as in presence of photogenin, photophelein is rapidly used up with light production, so in presence of extract of the non-luminous cells of *Cypridina,* photophelein quickly disappears, but without light production. If we boil the non-luminous cell extract or exclude oxygen, the photophelein is not so rapidly used up. In the case of the firefly, the photophelein disappears so rapidly from an extract of non-luminous cells that it is necessary to extract them with boiling water to prepare a stable solution giving light with photogenin. Because of failure to boil the extract, I previously had overlooked the existence of photophelein in the non-luminous parts of fireflies. The evidence seems to indicate that boiling destroys a substance existing in non-luminous parts which oxidizes the photophelein.

Probably photogenin from different forms is different, at least there is a certain amount of specificity in the photogenin-photophelein reaction. Photogenin from *Cypridina* will give a faint light with photophelein from the firefly, but photogenin and photophelein of the same species or allied species give much the brightest light. For instance, firefly photogenin will give a brighter light with photophelein from other species of fireflies or even from *non-luminous* insects (*i. e.,* the boiled cell extracts of non-luminous beetles) than with *Cypridina* photophelein. Indeed, it may be found that the photogenins from different forms exhibit differences in light-giving power, depending on relationship, similar to the differences in the hemoglobins, or similar to the specificity of the precipitin reactions of different animals.

If Dubois's statement that *Pholas* luciferin will give light with oxidizing agents, that it is not destroyed by heat and is found only in luminous cells, be confirmed, we may perhaps look to two general methods of light production in the animal kingdom—one as in *Pholas,* the oxidation with light production of *luciferin* by luciferase so closely paralleled by pyrogallol and peroxidases;[4] the other, as in *Cypridina* and the firefly, through the interaction of photogenin and photophelein, the *photogenin* giving light by some mechanism which can not at present be definitely stated. The closest parallel is the zymase system. Just as zymase is inactive without its co-enzyme, so photogenin is inactive (will not emit light) without photophelein, and just as there are certain quantitative relations between zymase and co-zymase, so there are similar quantitative relations between photogenin and photophelein. As oxygen is necessary for light production, we may, perhaps, provisionally regard photogenin as a substance auto-oxidizable with light production only in the presence of photophelein.

E. NEWTON HARVEY
PRINCETON UNIVERSITY,
October 16, 1916

[4] Harvey, E. N., *Amer. Jour. Physiol.,* 1916, XLI., 454.

SCIENCE

FRIDAY, NOVEMBER 10, 1916

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

THE NATURE OF THE CHEMICAL ATOM[1]

THERE is probably no subject in physical science that has received more attention or produced a more profound influence on the theories of chemistry and physics during the last few years than that of the constitution of the atom. The problem has been attacked, not only by many of the foremost chemists and physicists of the world, but also by many eminent astronomers and mathematicians. It is one of the most difficult as one of the most important problems with which the chemist is concerned.

The conception of the atom became an important factor in chemical science early in the nineteenth century, when Dalton discovered the laws of definite and multiple proportions and announced his well-known atomic theory. He found that when one chemical element combines with another, it combines in a definite proportion or some integral multiple of that proportion. It was only natural that Dalton should have assumed this definite proportion, which he called an atom, to be an indivisible ultimate particle; and it was only natural that this theory should have prevailed throughout most of the nineteenth century, for, among the most prominent characteristics of the atom are its individuality and its permanency. It behaves in many respects like an indivisible particle.

Recent investigations, however, into the phenomena of the cathode rays, Lenard

[1] An address delivered at a meeting of the Southern California Section of the American Chemical Society, Los Angeles, California, Friday evening, October 22, 1915.

rays, canal rays, the Zeeman effect in the spectrum, X-rays and radioactivity have thrown a flood of light on the constitution of matter, and we now know that the atom is very complex in its structure. We know that certain chemical elements are undergoing changes which involve the actual disintegration of the atoms, a phenomenon accompanied by an evolution of energy far greater than that of any other known phenomenon. It has been definitely determined that in the partial disintegration of the atoms, where the atomic mass is reduced only a few per cent., there is set free, in some cases, more energy in the transformation of one pound of an element than is set free in the combustion of 100 tons of coal. Notwithstanding this enormous evolution of energy, these spontaneous, atomic disintegrations are apparently uninfluenced by external conditions, and move along with as much precision and law as the movement of the stars in their orbits. These remarkable phenomena and the intimate relation of electricity, radiant energy and chemical phenomena to atomic structure have brought the problem of the nature of the atom into great prominence in scientific literature.

The experiments of Crookes on the electric discharge in high vacua may be said to have opened the way for the experimental evidence of the complex nature of the atom. Plücker, Hittorf, Goldstein and others had previously investigated this subject, but the results did not become far reaching in their influence on scientific theories until Crookes published the results of his earlier observations in 1879. He found that, regardless of the nature of the residual gas in the exhausted tube or the nature of the cathode, the rays which are given off at the cathode consist of particles moving in straight lines, that they produce a brilliant glow on phosphorescent substances, that they exert a mechanical force and generate heat rapidly when intercepted, and that their trajectory is altered by the influence of a magnet.

Crookes did not carry these experiments to a successful conclusion, but so remarkable were the results that he concluded that the particles of the cathode rays represent a fourth state of matter which he called radiant matter. He said:

> We have actually touched the borderland where matter and force seem to merge into one another. I venture to think that the greatest scientific problems of the future will find their solution in this borderland and even beyond.

In a later communication he spoke of the "ultimate or rather ultimatissimate particles moving with incredible velocity," and of the possibility that elements with atomic weights higher than that of uranium might dissociate into simpler atoms. These statements were certainly prophetic of the important discoveries which were to follow.

Hertz and Lenard showed that the cathode rays would pass through thin plates of metal. They concluded that these rays, owing to their penetrating power, were a form of radiant energy. Later investigation, however, showed the Lenard rays to be identical with the cathode rays, and that both are due to moving particles.

The discovery of X-rays by Röntgen in 1895 gave a great impetus to the investigations on the electric discharge in high vacua. When the cathode rays are suddenly stopped by matter of any kind X-rays are produced. These rays are a form of radiant energy. The X-rays apparently originate in the interior of the atom, and each atom emits X-rays which are characteristic of its own structure. This subject will be referred to again.

Omitting some less important observations, we now come to the work of J. J. Thomson, 1897. He determined experimentally that the particles of the cathode

rays are neither atoms nor molecules, but are negatively charged particles, or corpuscles as he called them, much smaller than the atom. These experiments showed conclusively that the atom has a complex structure. Thomson measured the amount the particles, or electrons as they are now commonly called, are deflected by magnetic and electric fields of known intensities, and in this way determined the velocity of the particles and the ratio e/m, where e represents the charge and m the mass of a particle. This ratio has been determined by different experimenters, and has been found to be about 1.77×10^7.

In 1897 Zeeman observed that the lines in the spectrum are separated into two or more lines when the source of the light is subjected to the influence of a strong magnetic field. Zeeman and later Lorentz showed that such an effect would be produced if the lines in the spectrum are due to the vibration of electrons. They showed that the displacement would be proportional to the ratio e/m. Then from the amount of displacement the value of e/m was calculated and found to be approximately equal to the value determined by Thomson and others. The Zeeman effect has confirmed in a remarkable manner the existence of electrons, and proved them to be common constituents of all atoms. Various other phenomena show the existence of electrons, but it is unnecessary to consider all of these evidences.

Regardless of the source of the electron, the ratio e/m is constant, and is much larger than the corresponding ratio for the hydrogen ion. The latter ratio is 9,649, or almost 10^4. From the values of these two ratios, it is evident that the charge of the electron is much larger, or its mass is much smaller, than that of the hydrogen ion. Thomson and others have determined the magnitude of the charge of the electron and found it to be of the same order of magnitude as that of the hydrogen ion. The value generally accepted for this charge is 4.7×10^{-10} electrostatic units, or 1.59×10^{-20} electromagnetic units. If the charge of the electron is equal to that of the hydrogen ion, it is evident from the ratios given that the mass of the electron is only about 1/1800 that of the hydrogen ion or atom.

It occurred to Thomson that the exceedingly small mass of the electron might be entirely electrical in its nature. He had previously shown that a moving electric charge has a certain amount of mass which is independent of any matter with which the charge may be associated. He calculated that the mass due to a moving charge is equal to $\frac{2}{3}\, e^2/a$, where e represents the charge and a the radius of the sphere of action of the electron. The work of Thomson indicated clearly that the mass of the electron is purely electromagnetic in its nature, but it was difficult to show this conclusively with the particles of the cathode rays. Thomson calculated the relation of the mass to the velocity, and showed that the mass would increase rapidly as the velocity approached the velocity of light. The phenomena of radioactivity soon made it possible to test this theory.

Since the discovery of radioactivity by Becquerel in 1896, and the actual separation of radium from its ores by Mme. Curie, many eminent chemists and physicists have contributed to the investigations on radioactivity, and various radioactive substances have been discovered and isolated. In every case it has been found that radioactivity is caused by a spontaneous disintegration of the atom, a sort of an atomic explosion accompanied by an unparalleled evolution of energy.

Three types of radiations are given off by radioactive substances, the alpha rays, beta rays and gamma rays. The gamma

rays are a form of radiant energy similar to X-rays.

The beta rays consist of negatively charged particles which are identical with the particles of the cathode rays or electrons. The beta particles are thrown off with enormous velocities, almost equal in some cases to the velocity of light. These high velocities have made it possible to determine more definitely the nature of the mass of the electron. Kaufmann and Bucherer have both determined the velocities and masses of beta particles moving with different velocities. They found that the mass increase is equal to the calculated increase in the mass of a moving electric charge.

These results indicate clearly that the mass of the electron is entirely electromagnetic in its nature, and that the electron is in reality a disembodied electric charge. There is considerable experimental evidence to show that all electric charges are made up of some integral multiple of this charge, and that all electric currents are due to some kind of movements of the electrons. If we substitute the values of e and m in the equation $m = \frac{2}{3}(e^2/a)$, we obtain 2×10^{-13} centimeters as the value of a which represents the radius of the sphere of action of the electron. This value probably does not exceed $\frac{1}{20000}$ of the diameter of the atom.

The alpha rays from radioactive substances also consist of particles, but of an entirely different nature from that of the beta particles. They are slightly deflected by a magnet, and in the opposite direction from that of the beta particles, thus showing them to be positively charged. The ratio of the charge to the mass, that is e/m, has been determined and found to be about 4,820, which is one half the value of e/m for the hydrogen ion. The charge carried by the alpha particle is equal to about 9.3×10^{-10} electrostatic units, which is twice the charge of the hydrogen ion. From the foregoing relations, it is evident that the mass of the alpha particle is equal to four times that of the hydrogen ion, or approximately equal to the mass of the helium atom. Rutherford and Royd determined experimentally that, when the charge is neutralized by the surrounding matter, the alpha particle becomes a neutral atom of helium.

The counting of the alpha particles has confirmed in a remarkable manner previous estimates of the number of atoms and molecules in a given quantity of matter. This difficult experiment was performed by Rutherford and Geiger,[2] who constructed an apparatus which would automatically magnify several thousand times the electrical effect of individual alpha particles. They found that one gram of radium emits 3.4×10^{10}, or 34 billion alpha particles per second, and that one gram of radium in equilibrium with its products emits 1.36×10^{11} alpha particles per second.

Various methods have been employed to calculate the number of atoms and molecules in one cubic centimeter of gas. Probably the most reliable estimates are those based on Millikan's[3] determination of the magnitude of the atomic charge. As already indicated, this value is 1.59×10^{-20} electromagnetic units. It is well known that one electromagnetic unit of charge liberates 1.1657 cubic centimeters of hydrogen gas, at standard conditions of temperature and pressure. Knowing the amount of charge or current required to set free one atom, and that required to set free a known volume of hydrogen, it is a simple matter to calculate the number of atoms in one cubic centimeter. In this way it has been estimated that one cubic centimeter of hydrogen under standard conditions con-

[2] *Proc. Roy. Soc., A*, 81, p. 141, 1908.

[3] *Phys. Rev.*, 32, p. 349, 1911.

tains 5.4×10^{19} atoms, or 2.7×10^{19} molecules. Relative to this value, Millikan[4] says:

> To-day we are counting the number of atoms and molecules in a given mass of matter with as much certainty and precision as we can obtain in counting the inhabitants of a city. No census is correct to more than one or two places in a thousand, and there is little probability that the number of molecules in one cubic centimeter of gas under standard conditions differs by more than that amount from 27.09 billion billion.

One gram of radium in equilibrium with its products emits 1.36×10^{11} alpha particles or atoms of helium per second, or 4.20×10^{18} per year. It has been shown by experiment that one gram of radium in equilibrium produces about 160 cubic millimeters of helium per year. From this it is evident that 160 cubic millimeters contain 4.20×10^{18} atoms, and that one cubic centimeter contains 2.6×10^{19} atoms or molecules. The helium molecule contains but one atom.

Furthermore, one gram of radium itself emits 3.4×10^{10} alpha particles per second. Each atom of radium which emits an alpha particle becomes itself an atom of radium emanation which is a gas. It has been determined that one gram of radium is in equilibrium with 0.6 cubic millimeters of radium emanation. The period of average life of radium emanation is comparatively short, and the fraction which decomposes in one second has been definitely determined. Knowing then the volume which is being decomposed, and hence the volume which is being formed in one second, and knowing the number of atoms produced in one second, it is a simple matter to calculate that one cubic centimeter contains 2.7×10^{19} atoms or molecules. There is but one atom in a molecule of radium emanation.

The enormous number of atoms in a given quantity of matter may be illustrated in the following manner. If the atoms of hydrogen and oxygen in one cubic inch of water were arranged uniformly $1/100$ of an inch apart in a single layer, they would cover all the continents of the earth several hundred times.

Notwithstanding its extremely small size, the atom is complex in its structure, and is made up of parts exceedingly small in comparison with its own size. The problem which now commands so much attention is the determination of the nature and arrangement of these parts. We have seen that the negative electron is a constituent of all atoms, but so far no positively charged particle of similar magnitude has been observed. The alpha particles and the particles of the canal rays are positively charged, but these particles are atomic in their magnitude. Every neutral atom must contain a positive charge or charges equal in magnitude to the sum of the negative charges.

In 1902 Lord Kelvin[5] suggested that the atom consists of a uniform sphere of positive electrification the size of the atom, throughout which are distributed negative electrons of sufficient number to neutralize the positive charge. In 1904 J. J. Thomson[6] developed this theory mathematically and showed under what conditions such an atom would be stable, and how various configurations would cause periodicities in the properties of elements as observed in the Periodic System. Thomson has given us the most elaborate discussion of atomic structure which has yet been offered, and has accounted in a remarkable manner for the chemical and other phenomena which the different atoms exhibit. During the last few years, however, some phenomena have been observed which would be difficult

[4] SCIENCE, January 24, 1913.

[5] *Phil. Mag.*, 3, p. 257, 1902.

[6] *Ibid.*, 7, p. 237, 1904.

to explain on the assumption that the positive charge is atomic in its dimensions.

This brings us to the consideration of an atomic structure which is supported by a considerable amount of experimental work. The theory was advanced in 1911 by Rutherford,[7] and was suggested by some experiments of Geiger and Marsden[8] on the scattering of the alpha particles. They observed that the alpha particles from a radioactive substance are deflected from their paths on passing through thin films of metal. They found that the amount of scattering varied with the velocity of the alpha particles, with the thickness of the metal, and with the atomic weight of the metal. It was observed that an occasional particle was deflected through 90° or more and was actually turned back in its course. In order to account for these occasional large deflections, Rutherford assumed that the positively charged alpha particles come into intimate contact with the atoms of the scattering material, and that the deflections are due to the influence of the two electric fields. This would necessitate that the charges be highly concentrated, so he assumed that the atom consists of an exceedingly small nucleus with a strong positive charge, surrounded by negative electrons distributed throughout the rest of the atom. He then calculated the result of an intimate encounter of an alpha particle with the nucleus of an atom, and found that the path of the particle would assume an hyperbolic curve. He calculated the relative number of alpha particles that would be deflected through different angles, and showed that the number of large deflections would be exceedingly small.

Geiger and Marsden[9] in 1913 made an elaborate series of experiments in order to test these theoretical deductions. They experimented with metals of different thicknesses and different atomic weights, and obtained results in accordance with Rutherford's calculations.

According to the theory of Rutherford, when alpha particles pass through hydrogen gas, an occasional atom of hydrogen should acquire, through an intimate encounter with an alpha particle, a velocity of 1.6 times, or a range of about 4 times that of the alpha particle. Marsden[10] tested this theory experimentally in 1914. He observed that with his apparatus the alpha particles had a range of 20 centimeters, as determined by their scintillations on a screen of zinc sulphide; and that an occasional hydrogen atom produced scintillations as far as 90 centimeters.

Various lines of investigation support the theory that alpha particles, on passing through matter, occasionally come into intimate contact with atomic nuclei, and that the large deflections are due to such encounters. Wilson's[11] photographs of the actual tracks of alpha particles indicate that such encounters occur. The deflections of the alpha particles obey certain laws which have been worked out by Rutherford on the theory that each atom consists of an exceedingly small nucleus with a positive charge surrounded by negative electrons. The nucleus, in many cases, is probably made up of both positive and negative electrons, the positive charge being always in excess. The algebraic, not the arithmetic, sum of the positive and negative charges in the nucleus represents the nuclear charge, and is always equal to the sum of the charges of the negative electrons surrounding the nucleus.

Darwin has calculated from the velocity given to the hydrogen atom by the alpha

7 *Ibid.*, 21, p. 669, 1911.

8 *Proc. Roy. Soc., A*, 82, p. 495, 1909.

9 *Phil. Mag.*, 5, p. 604, 1913.

10 *Ibid.*, 27, p. 824, 1914.

11 *Proc. Roy. Soc., A*, 87, p. 277, 1912.

particle that the centers of their nuclei must approach within a distance of 1.7×10^{-13} centimeters. This value then would represent a maximum for the sum of the radii of the nuclei of the hydrogen and helium atoms. Rutherford has suggested that the nucleus of the hydrogen atom may be the long sought positive electron, and that its dimensions may be considerably smaller than half of the maximum dimensions given above.

The small dimensions of the nucleus offer a possible explanation of the fact that most of the mass is concentrated in the nucleus, provided the mass is electromagnetic in its nature. As already observed the electromagnetic mass of a body is $\frac{2}{3}(e^2/a)$, where e is the charge and a the radius. According to this formula the mass increases as the radius decreases. If the mass of the hydrogen atom is to be explained on this basis, the radius of the nucleus must be about $\frac{1}{1800}$ that of the negative electron. Rutherford suggests that there is no experimental evidence contrary to such a view, and that its simplicity has much to commend it.

Assuming the atom to have a structure similar to that suggested by Rutherford, the determination of the nuclear charge or, what amounts to the same thing, the number of external negative electrons becomes an important matter. Geiger and Marsden calculated the nuclear charge from the number of alpha particles deflected through a definite angle by metallic films of known thickness, and found it to be approximately equal to one half the atomic weight times the charge of an electron. Barkla[12] in 1911 experimented on the scattering of X-rays, and determined the number of electrons in a known quantity of matter. These experiments were based on the theory of J. J. Thomson that each electron scatters X-rays independently, and that an expression for the scattering can be given in terms of the number of electrons. In this way the number of electrons in the atoms of several elements was found to be approximately equal to one half the atomic weight in terms of hydrogen.

Various lines of investigation indicate that the number of external negative electrons, and hence the magnitude of the nuclear charge, is approximately equal to one half the atomic weight in terms of hydrogen. In the case of hydrogen, however, it is evident that the number of electrons can not be equal to one half the atomic weight. This has led to an important suggestion by van den Broek,[13] that the number of unit charges on the nucleus, and consequently the number of external negative electrons in any atom may be equal to the number of the corresponding element, when the elements are arranged in the order of increasing atomic weights. For example, hydrogen, the first element, would have one electron and one unit charge on the nucleus; helium, the second element, would have two electrons and two charges on the nucleus; carbon, the sixth element, would have six electrons and six charges on the nucleus, and so on. This number is known as the atomic number, and has become an important constant in chemistry.

Among the most important experiments bearing on the subject of atomic numbers are those of Moseley[14] on the "High Frequency Spectra of the Elements." The interference phenomena of X-rays when reflected from a crystal surface have made it possible to determine the wave-lengths and vibration frequencies of these rays. This subject has been especially investigated by W. H. and W. L. Bragg. There are at least two kinds of X-rays, the K or

[12] *Phil. Mag.*, 21, p. 648, 1911.

[13] *Phys. Zeit.*, 14, p. 33, 1913.

[14] *Phil. Mag.*, 26, p. 1024, 1913; 27, p. 703, 1914.

penetrating rays and the L or soft rays. Moseley subjected a large number of the elements to a bombardment of the cathode rays and determined the vibration frequencies of the resulting X-rays. He found that the vibration frequency increases with increase in atomic weight. In the first series of experiments the K series of X-rays from the different elements were reflected from a crystal surface, and the spectra photographed. Each element produced two characteristic lines. On passing from one element to the next higher in atomic weight the two lines were shifted toward the violet end of the spectrum. In this way a remarkable relationship was established. Moseley found that the vibration frequency is equal to $A(N-b)^2$, where A is a constant and b is equal to unity. N is a whole number which increases by unity on passing from one element to the next higher in atomic weight. As aluminium is the 13th element, Moseley gave N a value of 13 for this element, and determined the corresponding value of A. With the value of A thus determined, the other elements gave values for N equal to their respective atomic numbers; thus, aluminium 13, silicon 14, calcium 20, iron 26, cobalt 27, nickel 28, and so on up to silver 47. With elements of higher atomic weights, the L series of rays were used, and the investigations extended to gold, for which $N=79$. For these rays, five lines were visible instead of two. The same formula could be used, however, by changing the values of the constants A and b.

Moseley found that known elements correspond with all numbers from 13 to 79 except three. These elements may be discovered later. Moseley suggests that the presence of a new element and its place in the periodic system can be quickly determined by this method. These results show that some fundamental property of the atom changes step by step on passing from one element to another in the periodic system. Moseley concluded that as N is equal to the atomic number, it represents the magnitude of the nuclear charge, and that this charge changes by unity on passing from one element to the next. It will be noticed that these results reverse the order of cobalt and nickel, indicating that the magnitude of the nuclear charge is more reliable than the atomic weight as an index of quality.

The theory that the chemical and physical properties of an element are closely related to the nuclear charge of the atom is supported by recent observations on the radio-elements.[15] Some important generalizations relative to the nature of these elements have been made during the last few years, and the large gap in the periodic system between the elements bismuth with an atomic weight of 208 and uranium with an atomic weight of 238 is now occupied by more than 30 radio-elements which are apparently true chemical elements.

As already observed, radioactivity is a property of the atom. It is caused by a disintegration of the atoms. There is, however, no gradual disintegration. Each atom of a radio-element is stable until it undergoes a sort of an explosion and ejects an alpha or beta particle, which changes it to a different atom and a different chemical element. Each radio-element has its own characteristic radioactive constant which represents the fraction of the whole amount which disintegrates in unit time. The reciprocal of this constant represents the period of average life. This period varies from a very small fraction of a second to several billions of years for the different radio-elements.

When a radio-element ejects an alpha

15 For references see Soddy's "The Chemistry of the Radio-Elements," Vols. 1 and 2.

particle it not only changes to a different element, but the atomic weight of the element is reduced by the weight of the alpha particle, which is 4 units. As the alpha particle carries two units of charge, its ejection removes two units of charge from the nucleus of the atom, which changes the valency of the element and shifts it two places to the left in the periodic system. The emission of a beta particle produces no appreciable change in the atomic weight, but adds one unit of positive charge to the nucleus, which changes the valency and shifts the resulting element one place to the right in the periodic system. For example, uranium in group VI. with an atomic weight of 238 emits an alpha particle and becomes uranium-X_1 in group IV. with an atomic weight of 234; this emits a beta particle and becomes uranium-X_2 in group V. with an atomic weight of 234; this emits a beta particle and becomes uranium-2 in group VI. with an atomic weight of 234; this emits an alpha particle and becomes ionium in group IV. with an atomic weight of 230; this emits an alpha particle and becomes radium in group II.; this emits an alpha particle and becomes radium-emanation in the zero group; and so on through the *A, B, C, D, E* and *F* products. The latter product, which is polonium, emits an alpha particle and becomes the end product, which is probably lead. The thorium series and the actinium series pass through cycles similar to that of uranium.

When these elements are arranged in the periodic system, it happens in some cases that several elements occupy a single position in the table. A large amount of work has been done on these elements, and it has been found that in every case, where several elements occupy a single position in the periodic system, they are, so far as known, chemically identical and non-separable. Soddy has suggested the term "isotopes" for such elements.

The behavior of the radio-elements confirms to a remarkable degree the theory that the chemical and physical properties of an element depend more on the nuclear charge of the atom than on the atomic weight. The determination then of the atomic number which represents the magnitude of the nuclear charge of the atom becomes an important problem in chemistry.

This brief but incomplete outline shows that the first great advance in the determination of the nature of the atom has been made. Much work is now being done, but much remains to be done before we can assume a definite structure to the atom. Various hypothetical structures have been suggested, especially by Bohr and Nicholson, who have accounted in a remarkable manner for certain series of spectral lines. Various theories have been suggested to account for the stability of atoms with rotating electrons. These theories are based, both on the arrangement and the manner of rotation of the electron, and on the manner in which an electron radiates energy. A more accurate knowledge of the nature of the atom will probably be necessary before its stability can be satisfactorily explained.

In the disintegration of the radio-elements we have definite evidence of the changes of various elements into other elements. These transformations have brought into prominence again the problem of how the various chemical elements have been built up, and the problem of transmutation again becomes a legitimate problem for the chemist to investigate. When we consider the unparalleled amount of potential energy associated with the atom, and the intimate relation of radiant energy and electricity to atomic structure; and when we consider that the supply of energy is the most fundamental problem

with which mankind is concerned, and that the energy which supplies the world to-day is being derived largely from a rapidly diminishing supply of fuel stored up in the past, it is evident that atomic structure is one of the most fundamental problems with which science is concerned.

I know it would be presumptive to assume that we shall sometimes be able to utilize the energy which is stored up in the atom, and, on the other hand, it would be equally presumptive to assume that the atom is the barrier beyond which science can not go. The history of science contains numerous examples of these barriers which have been placed by scientists themselves, and which in many cases have fallen before the conquest of these same scientists. Maxwell said the "atom is incapable of growth or decay, of generation or destruction." We now know that certain atoms are disintegrating, and new atoms forming continually. Less than a century ago scientists assumed that a "vital force" was essential in the formation of organic compounds. To-day thousands of such compounds are being synthesized in the laboratory, and many useful products are being made which, so far as known, the "vital force" has never produced. When Hertz succeeded in producing electromagnetic waves which are now the basis of wireless telegraphy and telephony, he thought it would be impossible to make use of such waves to transmit signals to any great distance. And so on, the unknown and apparently the unknowable of one generation may become the commonplace knowledge of the next. We do not know to what extent we shall be able to solve the mysteries of the atom, and we are unable to even predict the consequences of such a discovery. We know that the problem is beset with almost insurmountable difficulties, and that our knowledge on the subject can never reach finality.

The interior of the atom is the common ground where chemistry and physics meet, and there is probably no problem before the scientific world to-day that offers greater difficulty or promises greater reward than that of determining the nature and arrangement of the constituents of the atom, and the laws which govern their motion. The discoveries already made in this direction have broadened the range of scientific research, and advanced our knowledge one step farther into the mysteries of nature; and it is largely the mastery of man over the laws of nature which marks the progress of the world.

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ON THE UTILITY OF FIELD LABELS IN HERBARIUM PRACTISE

Routine technique in ordinary herbarium practise has made little advance for many years, in sharp contrast to the highly specialized technique in most other fields of botanical work. It is true that no revolutionary changes are to be expected in herbarium methods, yet the author is convinced that some changes are urgently needed in order that the great herbaria now so rapidly being built up in this and in other countries shall be more generally useful than they are to-day.

It is perhaps a survival of the Linnean idea that the name of the plant was the important thing to record on the specimen, and that all other data were secondary, that is reflected in modern herbarium practise. We have advanced, however, to the point where it is conceded by all botanists that the conventional data, geographic locality, collector and date of collection must be added to each specimen, yet many botanists and collectors do not realize the vital necessity of recording in a form that will be available to other workers essential data regarding the plant itself. The result is that the chief value of most large herbaria, aside from supplying material by which the limits of variation may be determined, or the limits of species decided, and in

supplying material on which the descriptions of new species may be based, is in determining the geographic distribution of various species, their dates of flowering and fruiting, and their collectors. What a relatively small return for the time, labor and money expended in building up any large herbarium! Perhaps the average curator is too conservative, yet conservatism carried to the point of not adding any data to the average mounted herbarium specimen other than the conventional Latin name, geographic locality, collector and date of collection of the plant, is absurd. Yet any one who has had long experience in most herbaria will fully realize that collection after collection received with data in some form about the specimens themselves, is often eventually distributed into the herbarium with most or all of the special data eliminated or at least very greatly abbreviated.

Perhaps the weakest point in all large herbaria is the lack of special data with the mounted specimens. The average herbarium, no matter how large or where located, will yield comparatively little information about the plants themselves other than the data that can be determined from the dried specimens and the conventional data usually recorded. As to the individual species, habit, habitat, altitudinal range, size, except for small plants, relative abundance, odor when fresh, color and odor of the flowers, special characters of the fruits not shown by dried specimens, the presence or absence of milky juice, gums or resins, vernacular names, economic uses, etc., can not be determined from a very high percentage of all extant herbarium material, chiefly because the data covering these points are not recorded by the average collector or botanist, or if recorded are not attached to the mounted herbarium specimen in average herbarium practise.

No botanist, from field work, can intimately learn the special characters of more than a few thousand species of plants, and unless he records special data in some form, he will frequently find his memory at fault regarding this or that character of this or that species. The average herbarium will give him little or no assistance, as so few specimens present any special data regarding the plants themselves. This fault in current herbarium practise is apparently reflected in some of our modern manuals, where, for some species, the size of the plant is not given at all, or is inaccurately given, the color of the flowers ignored, and other data that would be of distinct value to the field botanist, are frequently wanting. It is very probable that many of the vernacular names cited in our manuals are not now in use in the United States except as they are learned from the manuals themselves, that is, book names, and undoubtedly hundreds of vernacular names in more or less common use are unrecorded. Scores of "common names" have no existence except in print, being often merely a translation of the Latin name. How much better it would be to cite an actually used vernacular name, even if known only in a limited region, than to coin a common name by the simple process of translating the Latin one, and thus establishing in print a name that nobody ever uses. Yet probably no herbarium in the United States gives any appreciable amount of data as to vernacular names actually in use for the simple reason that botanists and collectors have neglected to record such names with the specimens.

A herbarium to be of the greatest service should present not only the geographic range of the various species, their period of flowering and fruiting, and when and by whom collected, but also the essential data regarding the individual plants themselves indicated above. In other words a properly prepared herbarium should be a card index to the various aspects of the species represented by dried specimens, their economic uses, vernacular names, and all possible information regarding the individual plants themselves that the dried specimens and usually recorded conventional data do not show.

The local botanist or collector may, and often does, record copious notes in various types of notebooks, but usually such notes are available only to himself, never become actually attached to his herbarium specimens, and ultimately become lost. If the collector does

not attach his notes to his specimens it can hardly be hoped that some other person will do it for him.

Those herbaria that are rich in original collections should present the most data regarding the plants themselves, yet very little attention is given to the eminently practicable and logical procedure of recording notes with the specimens in most herbaria. In almost any large herbarium case after case could be cited where original data regarding the plants themselves recorded on the specimen sheets, on slips of paper, or in notebooks, have deliberately been discarded either because it was not recognized herbarium practise to record such data, or at least to attach the data to the herbarium specimen; because the ultimate value of such data was not realized; because there is no generally recognized place on herbarium sheets for recording miscellaneous data; or perhaps more often because of the time involved in copying data from crude field notes. This brings up a vital phase of the subject, and that is, even if the original data be carefully copied on the herbarium sheet, the *original notes*, no matter how crude, should always be attached to the sheet as a part of the record.

Perhaps one potent reason why in ordinary herbarium practise little special data is recorded with the specimen is that the average herbarium label is too small on which to record more than a small fraction of the data that might or should be recorded with the specimen. In the opinion of the author the conventional herbarium label is no place on which to record other than the data for which it was designed, the name, locality, collector and date of collection. For esthetic reasons many botanists are opposed to writing on the herbarium sheet, and aside from the herbarium label itself, there is no recognized place on the sheet for recording special data. The question of time and labor is also involved, for under common practise special data must be copied from a notebook or compiled from memory. The problem of recording data with the mounted specimen with the least possible loss of time and labor, is solved by the adoption of a field label.

The urgent need of some radical change in current American herbarium practise is not fully realized, and in the matter of recording special data on mounted botanical specimens American institutions are, on the average, about the same as those of other countries. Fifteen years' work in systematic botany in many different herbaria in the United States, in Europe, in Asia and in Malaya, and my own experience in establishing and building up the herbarium of the Bureau of Science in Manila, has led me to prepare the present paper with the hope that it may lead to a higher average of herbarium practise as to the recording of data about the individual species. To give some definite idea of the great lack of special information about the plants themselves, as recorded in the average herbarium, I have compiled data from 3,000 mounted herbarium specimens, taken at random from three types of herbaria. Care was taken in each case, however, so to select the sheets that families presenting trees, shrubs, vines and herbs were included. In one case not less than 75 per cent., and in two cases over 90 per cent. of the sheets represented the original specimens, that is, the first set, whenever duplicates were prepared, and material primarily collected for the institutions to which the herbaria belong. In not a single case did the special data record on any specimen exceed fifteen words on the 3,000 sheets examined, the average certainly not exceeding five words. In separating the specimens into two categories, one with special data and one without, if a single word such as "tree," "forests," "swamp," etc., was added beside the conventional Latin name, locality, collector and date of collection, the specimen was placed in the group with special data.

In a large collection assembled over the course of more than forty years, the combined results of the field work of many botanists and collectors for the purpose of working up a local flora, of 1,000 sheets examined less than 10 per cent. presented any data regarding the plants themselves. Over 90 per cent. presented merely the conventional data, Latin name, locality and date of collection, collector; not a word regarding even the size, habitat or

special characters of the plant or its parts. The botanist who utilizes this large collection for the purpose of writing a local flora must himself go into the field and to a large degree determine anew the special data that should have been accumulating during the past forty years regarding the special characters of each individual species found in the area covered by the collection. To-day nobody can determine what original notes were made by the various collectors, and unquestionably observations or notes were made when most or all of the specimens were actually collected.

In a much larger collection of exotic plants, a collection still apparently rich in species as yet undescribed, and a collection in which at least 75 per cent. of the sheets represent *original* collections, less than 8 per cent. of the sheets bear any data whatever other than the conventional Latin name (so far as the material is identified), collector, locality and date of collection.

In a third collection, a herbarium of economic plants, presenting chiefly those species actually cultivated for agricultural or horticultural purposes, on a basis of 1,000 sheets examined, less than 3 per cent. of the sheets present any data regarding the plants themselves. It is estimated that at least 95 per cent. of this herbarium represents *original* collections.

In contrast to the above three herbaria I wish to cite the one in which I am especially interested, the contrast of which has led me to prepare this paper, and that is the herbarium of the Bureau of Science in Manila. In this herbarium there are now approximately 160,000 mounted sheets, of which about 100,000 are Philippine, the remainder chiefly from surrounding regions. The extra-Philippine material, except that collected by employees of the Bureau of Science, as to special data recorded with the specimens, is quite like similar material received in exchange by other institutions. Taking into consideration only the Philippine material, approximately 75,000 sheets, or 75 per cent. of this part of the herbarium, present special data regarding the plants themselves recorded on field labels of one type or another. These field labels were filled out when the plants were collected, were placed with the specimens in press, remained with the specimens through all processes until the mounted sheet was distributed into the herbarium, and the accumulated data thus recorded has added immensely to the value of the herbarium. The notes with the specimens represent the combined field observations of perhaps 100 different American and Filipino collectors, and the botanist working with this material has at once available a great mass of information that is not to be found at all in the average herbarium, and information that no single collector could possibly secure in any reasonable time. The herbarium is what it ought to be, an index to the various aspects of Philippine botany from both an economic and a scientific standpoint. It is consulted not only by systematic botanists, but also by foresters, agriculturists, horticulturists, philologists and others interested in the economic aspects of botany.

In a very few European herbaria field labels have been used for a number of years, but in general their great utility has been quite overlooked by botanists, collectors and curators of herbaria, and in most herbaria are quite unknown. Every European field label I have seen presents what I consider to be serious defects either in form, in size or in indicated data to be recorded. From my early work in the United States Department of Agriculture I was familiar with the types of labels used for field work in the Division of Agrostology, which were sometimes attached to the mounted sheets, and sometimes not; these labels had a fatal defect in that the attempt was made to combine a field label with a herbarium label, and their use was eventually abandoned. In establishing the botanical work in the Philippines in the year 1902 I was immediately impressed with the necessity of recording data about the plants themselves in such form that it could be recorded with the mounted specimens. The first field label adopted was exceedingly crude and experience on a single field trip proved that it was utterly unadapted to the purpose in view. In the meantime, however, I became acquainted with the forms de-

veloped by Dr. S. H. Koorders for his field work on the forest flora of Java,[1] and a modified form of the smaller type of label used by him was adopted for use in the Philippines early in the year 1903. From

FLORA OF THE PHILIPPINE ISLANDS
HERBARIUM, BUREAU OF SCIENCE

Common name .... Dialect ......
Field No. .... Herbarium No. ....
Collector ....
Island of Province ....
Locality ....
Habitat ....
....
Altitude above the sea ....meters
Tree; shrub, bush; vine; herb ....
Height of plant ....M.
Diameter of plant, breast high ....Cm.
Flower ....
(Odor, color, etc.)
....
Fruit ....
(Kind, odor, color, etc.)
Special notes ....
....
Economic uses ....
....
Date ....

FIG. 1. A FIELD LABEL FOR GENERAL PURPOSES. Actual size 15.5 × 8.5 cm.

time to time changes were made in the arrangement of the printed data on the label, as the field experience of myself and associates seemed to warrant, until the label finally assumed the form presented in Fig. 1, in actual size 15.5 by 8.5 centimeters. Fig. 2 represents a somewhat modified form of the label as adapted to a special purpose, that is, the botanical exploration of Amboina with special reference to data that is essential in interpreting the species figured and described by Rumphius in his "Herbarium Amboinense."

FLORA OF THE MALAY ARCHIPELAGO
HERBARIUM, BUREAU OF SCIENCE, MANILA, P. I.

Common name .... Dialect ......
Field No. .... Herbarium No. ....
Collector, C. B. Robinson
Island ....
Locality ....
Habitat ....
Altitude above the sea ....M.
Tree; shrub; woody vine; herbaceous vine; herb ..
....
Height of plant .... m.; diameter ....cm.
Flower ....
....
Fruit ....
Supposed to represent ....
....
Rumph. Herb. Amb. ....
....
Identification considered certain; probable; possible; very doubtful.
Date ...., 19

FIG. 2. A FIELD LABEL FOR A SPECIAL PURPOSE. Actual size 15.5 × 8.5 cm.

The field label as developed for the botanical work in the Philippines is presented not with the idea that it presents, as to printed form and data, the label that is best for general use in other countries, but merely the label that twelve years' experience has shown to be best adapted to our purposes in the Philippines. It is doubtful, however, if the shape and size could be improved upon, but the printed data could be modified to suit the country in which collections are to be made, or to suit the pur-

[1] Merrill, E. D., "Report on Investigations Made in Java in the Year 1902," Philip. Forestry Bureau Bull., 1: 60–63, 1903.

poses of the collector if he confines his field work to special groups of plants. A label, if made too small, will interfere with the proper handling of mounted herbarium specimens if it is attached where it should be placed, that is, at the *upper left-hand corner* of the herbarium sheet. If made too large and complex too much time is involved in properly filling it out. The label now used in the Philippines assumed its present form largely because much of the field work of necessity must be carried on by men with little botanical training. To an inexperienced collector, then, a field label serves as an indicator as to the data that is of the most value, and the data that should be recorded in order that the specimen when finally mounted, shall present as many facts as possible about the plant that are not shown by the dried specimen itself.

I know of no serious objection to the use of field labels, and by their use an enormous mass of most valuable information can be recorded in such form that it will be available to other botanists than the collector, data that is not now being recorded at all, or if recorded is, except in special cases, never attached to the mounted herbarium sheets. From long personal experience with field labels, and judging from the experience of many others who have used them in the Philippines, it is confidently prophesied that the average collector or botanist who adopts a logical compact form for recording his notes on field labels, and who once fully appreciates the advantages and simplicity of the system, will never revert to the now almost universal and decidedly impracticable method of recording notes on the specimen sheets or in a notebook.

Objections that have been offered to the use of field labels are not especially valid. In practise the size adopted in the Philippines will not be found to be too great; it is approximately the size of generally used pocket notebooks; it takes up little space on the mounted sheet, and if properly placed does not in the least obscure the mounted specimen, or interfere with the handling of the herbarium sheets. Scanty or copious notes may be taken at the discretion of the collector. A specially modified form may be adopted for special groups of plants, such as ferns, lichens, fungi, grasses, etc., or for special types of herbaria, such as dendrological collections, agricultural or horticultural plants, etc. The field label is not too complex, and the printed form can be filled out much more rapidly than can a similar amount of data be recorded on a blank page. Under all but the most abnormal field conditions the label can readily be filled out when the plant is collected, or soon after the specimens are placed in press and before the collector's conception of the plant has become dim. To the objection that the labels can not properly be filled out when one is heated and perspiring from field work, I can merely point to the 40,000 specimens in the Javan collections of Koorders, and nearly twice this number in the Philippine herbarium, all of which were filled out in the field in tropical and not in temperate regions, and often under the most adverse climatic conditions.

If it is considered desirable the labels can be numbered serially before commencing field work, thus avoiding the danger of duplicating or of skipping numbers. In all cases, however, the field label should be placed with the specimen it describes in press, and should remain with the specimen under all circumstances and through all processes until the mounted sheet is distributed into the herbarium. In practise it has been found much more convenient to have the labels perforated at the top, that they may readily be removed, and bound into notebook form, 100 labels to a book. It sometimes happens that it is desirable that the collector retain his notes in serial form. This is very readily accomplished by utilizing a carbon paper and making two copies of the label, one to be removed from the book and placed with the specimen, one to be retained in the book in its serial place; the original label may be white, and the duplicate on pink or yellow paper.

The proper place for the field label on the mounted herbarium sheet is in the *upper left-hand corner*. Here it interferes less with the mounted specimen than in any other position and causes the least trouble in handling the

mounted sheets. It should be attached merely by gumming the lower surface of the upper left-hand corner of the label, and under no circumstances should the entire back of the label be pasted to the sheet. It frequently happens that it is necessary or desirable to record additional data on the back of the label, and again, if merely attached by the upper left-hand corner, the label can then be lifted or turned back should it cover any portion of the specimen that it is necessary or desirable to examine.

The advantages of a comprehensive system of field labels are very great, and their use should appeal to the most conservative botanist. The addition of the field label to the mounted sheet does not detract from the appearance of the mounted specimen, it supplies a proper place for recording data regarding the plant itself that otherwise, if recorded at all, must be abbreviated and crowded on the small herbarium label or laboriously copied on the sheet itself, and if consistently used will preserve in a form available for other contemporary workers as well as for future botanists a mass of information regarding the plants that is now not being recorded at all, or if recorded, is rarely attached to the actual mounted specimens and ultimately becomes lost.

E. D. Merrill

Bureau of Science,
Manila, P. I.

NATIONAL ACADEMY OF SCIENCES

The autumn meeting of the National Academy of Sciences will be held on Monday, Tuesday and Wednesday, November 13, 14 and 15, 1916, in the new buildings of the Massachusetts Institute of Technology, adjoining the Charles River Basin in Cambridge, with headquarters across the Basin at the Harvard Club, 374 Commonwealth Avenue, in the Back Bay district of Boston. Hotels Puritan and Somerset, in the same block with the Harvard Club on Commonwealth Avenue, will be convenient for members accompanied by their families. Luncheon will be provided for members and ladies accompanying them at Riverbank Court, adjoining the Institute buildings on Monday and Tuesday, and at several of the neighboring scientific institutions on Wednesday.

It has been found necessary to postpone the William Ellery Hale lectures, previously announced to be given by Professor E. G. Conklin on Monday evening and Tuesday afternoon, November 13 and 14. The Monday evening lecture will be replaced by an introductory address by President W. H. Welch on the Formation of the National Research Council at the request of the President of the United States and a lecture by Dr. S. W. Stratton, director of the National Bureau of Standards, on the Target Practise in the Navy and some of the Research Problems involved, illustrated with moving pictures. The Tuesday afternoon session will be devoted to reports by members of the National Research Council.

At the close of the Monday evening session a reception will be held by President and Mrs. Maclaurin of the Massachusetts Institute of Technology and President and Mrs. Lowell of Harvard University, in the General Library where a scientific exhibit will be displayed. On Wednesday there will be visits to scientific institutions in and near Boston.

The local committee consists of W. M. Davis, chairman, W. T. Councilman, A. A. Noyes and E. C. Pickering.

The program of papers to be read at the meeting is as follows:

Monday, November 13

From 2.00 to 3.30:

Welcome by President Maclaurin, of the Massachusetts Institute of Technology.

Raymond Pearl, Maine Agricultural Experiment Station. Some Effects of the Continued Administration of Alcohol to the Domestic Fowl, with special Reference to the Progeny. (20 minutes, lantern.)

Edward S. Morse, Salem, Mass. Protoconch of *Solemya*. (10 minutes.)

Alfred G. Mayer, Marine Laboratory, Carnegie Institution. Further Studies of Nerve Conduction. (10 minutes, lantern.)

E. G. Conklin, Princeton University. The Share of Egg and Sperm in Heredity. (10 minutes, lantern.)

Jacques Loeb, Rockefeller Institute. Diffusion and Secretion. (12 minutes.)

Lafayette B. Mendel and S. E. Jordan, Yale University. Some Interrelations between Diet, Growth and the Chemical Composition of the Body. (12 minutes.)

Henry L. Abbot, Cambridge, Mass. Hydrology of the Isthmus of Panama.

John M. Clarke, State Museum, Albany. The Strand and the Undertow.

W. M. Davis, Harvard University. Sublacustrine Glacial Erosion in Montana.

Scientific Exhibit in the General Library, from 3.30 to 5.00.

From 8.15 to 9.15:

President W. H. Welch, Johns Hopkins University. The Formation of the National Research Council at the Request of the President of the United States. (15 minutes.)

Dr. S. W. Stratton, Director of the National Bureau of Standards, Washington. Target Practice in the Navy and Some of the Research Problems Involved; Illustrated with Moving Pictures. (45 minutes.)

Reception and Scientific Exhibit in the General Library, from 9.15 to 10.30.

Tuesday, November 14

From 10.00 to 12.30:

Edwin H. Hall, Harvard University. Electric Conduction in Metals. (20 minutes, lantern.)

Edward B. Rosa, National Bureau of Standards. The Silver Voltameter as an International Standard. (15 minutes.)

R. W. Wood, Johns Hopkins University. One-dimensional Gases and the Reflection of Molecules. Series in Resonance Spectra. (10 minutes, lantern.)

Elihu Thomson, Swampscott, Mass. Inferences Concerning Auroras. (20 minutes.)

A. A. Michelson, University of Chicago. Report of Progress in Experiments for Measuring the Rigidity of the Earth. (10 minutes.) The Laws of Elastico-viscous Flow. (10 minutes.)

C. G. Abbot, Smithsonian Institution. On the Preservation of Knowledge. (5 minutes.)

Franz Boas, Columbia University. Further Evidence Regarding the Instability of Human Types. (20 minutes.)

Ross G. Harrison, Yale University. Transplantation of Limbs. (20 minutes, lantern.)

Chas. B. Davenport, Station for Experimental Evolution, Carnegie Institution. Heredity of Stature. (20 minutes, lantern.)

From 2.30 to 5.00:

Professor George E. Hale, Chairman of the National Research Council. The Work of the National Research Council; Recent Observations of Organized Science in England and France. (45 minutes.)

Lieutenant Colonel George O. Squier, Chief of Aviation, U. S. Army. Scientific Research for National Defense, as Illustrated by the Problems of Aviation. (45 minutes.)

Professor Arthur A. Noyes, Massachusetts Institute of Technology. The Nitrogen Problem in War and in Agriculture. (30 minutes.)

Discussion of the Work of the National Research Council.

SCIENTIFIC NOTES AND NEWS

A MEETING to plan a memorial to the late Sir William Ramsay was held at University College, London, on October 31. After the meeting, the director of the University College Chemical Laboratories, Professor J. Norman Collie, F.R.S., delivered a memorial lecture on "The Scientific Work of Sir William Ramsay."

WE are informed by a correspondent who has just returned from Germany that the published statement that Dr. A. von Wassermann, of the University of Berlin, has succeeded Ehrlich as head of the Institute for Experimental Therapeutics at Frankfort-on-Main is incorrect and that Professor Kolle of Berne, holds this position temporarily.

PROFESSOR WILLIAM W. PAYNE, director of the Elgin Observatory, formerly professor of mathematics and astronomy and director of the Goodsell Observatory of Carleton College, and the founder of *Popular Astronomy*, was granted the degree of doctor of science by Carleton College on October 13, on the occasion of the celebration of the fiftieth anniversary of the founding of the college.

PROFESSOR W. A. NOYES, director of the chemical laboratory of the University of Illinois, will lecture on "The Electron Theory" as part of the program of the Franklin Institute, Philadelphia, for the year 1916–17.

ON October 26, Professor C. J. Keyser delivered an address before the assembly of Le-

land Stanford University on "Ways to Pass the Walls of the World." On October 27, he addressed the university meeting of the University of California on "The Ideals that are Most Worthy of Loyalty." During the current half-year Professor Keyser is giving instruction in the University of California in exchange of work with Professor M. W. Haskell, who is lecturing in Columbia University.

It is reported that Lieutenant-colonel J. George Adami, professor of pathology in McGill University, Montreal, who held the position abroad of official Canadian recorder of medical history of the war, has resigned and will soon return to Montreal.

Mr. John E. Mellish, who has been at the Yerkes Observatory for the past fifteen months as volunteer research assistant, will take charge of the well-equipped private observatory at Leetonia, Ohio, of Mr. Elmer Harrald.

Walter D. Harris, formerly assistant professor of physics at Syracuse University, has resigned his position with the United States Bureau of Chemistry to take an active interest in the Valhalla Co., Chicago, manufacturers of electro-chemical machinery.

Mr. E. W. Kerr has resigned his professorship in mechanical engineering at Louisiana State University to take up commercial work with the Cuba Cane Sugar Corporation, Havana, Cuba.

Dr. Leverett D. Bristol, for two years professor of bacteriology and hygiene and director of the city public health laboratory at the University of North Dakota, has accepted the newly created Boston dispensary fellowship in public health in the department of preventive medicine at Harvard Medical School, Boston.

Sir Ernest Shackelton, the Antarctic explorer, arrived in New Orleans, on November 3, on the steamer *Parismina*, from Colon, and departed several hours later for San Francisco, on his way to rescue ten members of the Shackelton party on the west side of the Antarctic continent. He expected to sail from San Francisco for Wellington, New Zealand, on November 8, going thence to Dunedin, where he and a rescue expedition will sail for the Antarctic on the *Aurora*.

Lieutenant-colonel E. Alexander Mearns, U. S. A., died in Washington, D. C., on November 1, in his sixty-first year. He was one of the founders of the American Ornithologists' Union, and a member of the Roosevelt East African expedition. Dr. Mearns was an indefatigable collector of natural history specimens all his life, and was the author of many contributions to zoology and botany.

Theodore Newell Ely, engineer and retired chief of motive power of the Pennsylvania railroad, died on October 28, at his home at Bryn Mawr, Pa., aged seventy years. Dr. Ely established a scientific department in the Pennsylvania Railroad in 1875. He had received the honorary degree of master of arts from Yale University and the doctorate of science from Hamilton College. In addition to membership in the national engineering societies, he was a member of the American Philosophical Society and a fellow of the American Association for the Advancement of Science.

Phillip H. Cary, a graduate of Oberlin College who had nearly completed the work for the degree of doctor of philosophy at the University of Minnesota, where he was specializing in paleontology and stratigraphy, died on October 27. Last January, when the call came for more men in the southwestern oil fields, he left his graduate work temporarily and was rapidly establishing a reputation as an oil geologist in Oklahoma.

Professor G. C. J. Vosmaer, of the University of Leiden, known to all zoologists for his valuable contributions on the morphology and classification of sponges, has died at the age of sixty-two years.

The death is announced of the distinguished psychiatrist Dr. Magnan, honorary chief physician of the Asile Sainte-Anne at Paris.

The twenty-fifth annual meeting of the American Psychological Association, in affiliation with the American Association for the Advancement of Science, will occur on Wed-

nesday to Saturday, December 27 to 30, in New York City. By invitation of the psychologists of Columbia University the sessions will be held at that institution. It is proposed to hold the regular meetings in Teachers College, 120th Street, between Broadway and Amsterdam Avenue. As headquarters the Hotel Marseilles at 103d Street and Broadway has been selected. This meeting marks the twenty-fifth anniversary of the association's foundation. An appropriate program commemorating the event will be held on Thursday afternoon, December 28. The annual banquet will also take place on Thursday, at 7 P.M., in the Hotel Marseilles. The program of after-dinner speakers for this occasion is in the hands of the anniversary committee. The president's address on "The Laws of Relative Fatigue" will be given by Professor Raymond Dodge, of Wesleyan University, at 8 P.M. on December 27, in Schermerhorn Hall. It will be followed by the annual business meeting of the association, and a smoker in the Psychological Laboratory. A joint session with Section L (Education) of the American Association for the Advancement of Science is planned for Friday morning, December 29. The program with additional notes on the meetings will be distributed to members early in December.

THE formation of the Association of British Chemical Manufacturers has been noted in SCIENCE. The association, which has been joined by the leading chemical firms of Great Britain, is now installed in offices at 166, Piccadilly. Sir Charles Bedford has been appointed general secretary, and Sir William Pearce, M.P., honorary treasurer. The chief objects of the association are: (1) To promote cooperation between British chemical manufacturers. (2) To place before government the views of the association upon matters affecting the industry. (3) To develop technical organization and promote industrial research and efficiency. (4) To facilitate the development of new British industries and the extension of existing ones. (5) To improve the methods of education in chemistry. (6) To finance researches undertaken in the interest of the industry. (7) To found scholarships or lectureships for the promotion of its objects. The financial strength of the association is guaranteed by the fixing of the minimum subscription at 25 guineas and the maximum at 250 guineas. The affairs of the association are to be managed by a council of 20, 16 elected and 4 coopted.

THE New York *Medical Journal* gives the following statistics in regard to the death rate in Germany which, after reaching the low record of 14 per mille in 1913, has followed a steadily ascending curve during the war. The figures for 1914 were 16.1 per mille, in 1915 there was an increase to 19.7, and the record for the first seven months of 1916 is 16. These statistics include civilians and soldiers. Infant mortality, however, continues to follow a descending curve. The number of deaths per centum new births, after showing a slight increase from 14.1 in 1912 and 1913, to 15.6 in 1914, dropped to 14.5 in the first year of the war. For the last year the percentage has been 12.9.

THE rate of growth of trees in woodlots and in plantations in Central New York is being studied by the junior class of the New York State College of Forestry under the direction of Professor J. Fred Baker, director of forest investigations. Soil and climatic conditions in central New York are unexcelled for maintenance and rapid forest growth. In fact, trees grow like weeds in New York and there is not a square foot in the state where there is any soil at all which will not maintain a good forest growth. The so-called virgin forests of the Adirondacks are growing to-day at the rate of about 200 board feet per acre per year. Properly managed forests, such as those of the Black Forests of southwestern Germany, are growing at the rate of from a 1,000 to 1,200 board feet per acre per year. Reasonable use of farm woodlots and the planting of the right kinds of forest trees on forest soils means the production of excellent crops of timber and that within a comparatively short period of time. The planting of trees along the highways of the state is being studied by Professor H. R. Francis, of the Landscape Extension Service of the College of Forestry at Syra-

cuse. Field studies and plans have already been prepared for portions of the main highway between Utica and Albany and the state highway between Utica and Syracuse is now being carefully studied. It is not the idea of Professor Francis to line the highways with straight rows of trees. Natural vistas showing beauty spots away from the highways will be left open, and it will be suggested that other vistas be made so that the highways will not alone be well planted with trees and shrubs, but there will be more nearly a park-like effect with opportunities of seeing the beauty of the country on either side. Professor Francis is urging the use of native trees and shrubs, taking advantage in so far as possible of the material on the ground. It is expected that these studies of highway planting will result in a publication showing just how definite areas of highway may be treated to best advantage. This will supplement a bulletin on "Suggestions for Street Tree Planting" which has already been given wide distribution by the college.

United States patents have been issued to Dr. Clifford Richardson on an improved "bituminous substance" and on the process by which this product is manufactured. Similar patents have also been granted in Canada, Great Britain, France and Italy. It is said that these are the first patents covering a product and process involving the introduction of colloidal matter into bitumens of all types. According to the inventor, he obtains "an increased degree of body or stability in these bituminous substances, by means of the addition to and intimate and uniform dispersion through the bituminous substance of a proper proportion of a substance in the state of a disperse colloid. The process consists in the introduction of clay in the form of a colloidal aqueous paste and combining this paste with the bitumen in such a way that when the water is subsequently driven off, the bitumen forms the continuous phase of the colloidal material. The products resulting from this method of incorporating clay in colloidal form with bitumen has markedly different properties from products into which the mineral matter is introduced in the form of a dry powder. The products made by the Richardson method range all the way from materials resembling vulcanized rubber to plastic, but at the same time very stable mixtures suitable for paving and many other uses.

The *Journal* of the American Medical Association reports that an institute for vaccines, bacteriology and chemistry at Buenos Aires was recently inaugurated. Penna, chief of the public health service, Malbran, chief of the bacteriologic service, and various professors with university chairs in these specialties, all delivered addresses. Magnin, chief of the chemical department, reported that already he had researches under way which might aid materially in remedying the scarcity of imported drugs. A number can be made and many are now being made in the workrooms connected with his department. An isolated pavilion has been set apart for a training school in applied chemistry. The national board of health has had a chemical department since 1880, but this new triple institute is said to be equipped for the science and needs of to-morrow as well as to-day.

UNIVERSITY AND EDUCATIONAL NEWS

The Carborundum Company of Niagara Falls, N. Y., will construct an administration building on lands of the Niagara Falls Power Company on the Niagara River front. It is proposed to tender the use of the present offices to the Massachusetts Institute of Technology, which has decided to establish a research laboratory at Niagara Falls.

Charles Gilman Hyde, professor of sanitary engineering in the University of California, has been appointed acting dean of its college of civil engineering, to serve during the present year because of the absence on account of illness of Professor Charles Derleth, Jr.

The following former members of the Medico-Chirurgical College faculty have been duly elected members of the faculty of under-

graduate medicine in the University of Pennsylvania: Dr. Joseph McFarland, professor of pathology; Dr. John C. Heisler, professor of anatomy; George H. Meeker, Sc.D., LL.D., professor of chemistry; Dr. Horatio C. Wood, Jr., professor of pharmacology and therapeutics, and Dr. Seneca Egbert, professor of hygiene.

Dr. D. D. Leib, instructor in mathematics at the Sheffield Scientific School, Yale University, has been appointed assistant professor of mathematics and physics at the Connecticut College for Women.

Dr. V. H. Young, formerly of the botany department of the University of Wisconsin, has been appointed assistant professor of botany in the State University of Iowa. He takes charge of the work in plant physiology and mycology.

Dr. Eugene P. Wightman has been appointed professor of chemistry at Richmond College to succeed Professor Eugene C. Bingham. Dr. Garnett Ryland, who was acting professor of chemistry at Richmond College last year, has returned to Georgetown College, Georgetown, Ky., after a year's leave of absence.

DISCUSSION AND CORRESPONDENCE

SCIENTIFIC APPOINTMENTS UNDER THE GOVERNMENT

To the Editor of Science: Discussion of the President's scientific appointments may tend perceptibly toward politics, which is to be regretted in a scientific journal. Nevertheless I am in entire accord with the views of your correspondent "R" in last week's number, with the exception of two lines, which I take leave to criticize. No doubt the Coast and Geodetic Survey is one of the most important of our scientific bureaus, and one of which we can be most proud. The men at the head of it, as described in his most interesting article in your issue of July 14 by Dr. T. C. Mendenhall (not excluding himself, as he modestly does), form a very distinguished company, and we all wish that the quality may be kept up. I at least wish that the President had seen fit to appoint a superintendent whose name could be found in "Who's Who in America." Nevertheless I am informed by those competent to know that the present superintendent is a very efficient head, and we know that many of the scientific bureaus have been at times under the direction of non-scientific persons who have succeeded admirably as administrators. Several of them are now under the direction of men who have not received the blue ribbon of election to the National Academy of Sciences, although some of their subordinates have done so. Even the Coast Survey was once under a chief clerk from another department. Personally I should be glad to see a geodesist at the head of the survey, which has, if I mistake not, never been the case. Even Dr. Mendenhall does not mention that one of the things that made the Coast and Geodetic Survey most famous in Europe was the remarkable work of Dr. Hayford in connection with the subject of isostasy, so that it appears that we have geodesists in this country, as well as hydrographers.

Personally it is no more repugnant to me to have a scientific bureau headed by a non-scientist than to have a university under the presidency of a person who is not a distinguished scholar, a contingency that is not unknown. Sometimes this works very well, as in the case of the late Seth Low, who converted Columbia from a provincial college into a great university. To be sure it is whispered that the power behind the throne was his present successor, but the case is a noteworthy one. Believing, as I do, that nothing is of more importance than learning, and in learning, than science, I do not wish to minimize the importance of the selection of suitable heads of learned and scientific institutions.

I come now to the matter which prompted the writing of this communication, and I take the liberty of being somewhat personal. I wish to protest against the characterization of "the recently organized and mobilized aggregation of assorted geniuses from which the President and the country at large are expecting so much." As a member of the Naval Consulting Board I am getting very tired of such sneers, and do not expect them from my scientific colleagues. I was named for that board by

the president of a society which I am proud to represent, and my colleagues, with two exceptions, were named in a similar manner. Can your anonymous correspondent suggest a better way to select members of such a board? I was not altogether pleased with the list of societies selected, and did not hesitate to say so. But I did not for that reason refuse to serve. None of the members of this board claims to be a genius, assorted or otherwise. I do not discuss the question whether Mr. Edison is the most wonderful man the country has ever produced. I know he invented the phonograph and the incandescent lamp, which is enough to have made him famous, even if he had then stood pat, like some others. But I know that he is a fertile and tireless worker, and I am glad to serve with him. During the past year I have attended nine or ten meetings of the board, at an expense to myself of over five per cent. of a year's salary as a professor, and at a still greater sacrifice of time, which, like the money, I can ill afford. But I have thought the sacrifice justified if I could be of some small use to the country at large. I have worked occasionally before for the United States government, and I do not expect pay—thanks it is not possible to get—but I do not expect to incur jibes from fellow-scientists. This is an age of cooperation, and I believe science is at the dawn of a great epoch. We all need to pull together. Under the circumstances I accordingly feel justified in calling upon "R" for an apology, disclaimer or disavowal—the word is unimportant—either in print, under his anonymity, which I do not ask him to break, or in private over his own name, which will be treated confidentially.

In case I have made a mistake, and the National Research Council is intended, the apology should be addressed to Dr. George E. Hale, but the principle is the same.

ARTHUR GORDON WEBSTER

October 23, 1916

PREPARATION FOR MEDICINE

DURING the past two years I have become convinced that there is a very typical course of college study through which prospective medical students are almost invariably passed. This conviction is based upon personal experience, recent enough to be very vivid, and upon conversations with many medical students.

Assuming that a man has selected his medical school, it is a very simple matter for his adviser to pick up a medical school catalogue and indicate that so much physics, so much chemistry, so much biology and such and such experience in French and German will be required in order for the student to enter the chosen school. These requirements can usually be met in two years of college work. Whether or not a college degree is necessary, the fact remains that the majority of the men in our best schools hold such degrees, and have therefore had at their disposal two extra training years. It is with these two years that I am concerned, for if they have been properly administered they can be of vast value, and almost always they are completely misdirected. A typical premedical student usually takes a year of physics, two years of inorganic chemistry, a course in organic chemistry with very deficient laboratory work, and finally a year of biology. These courses, as a rule, more than fulfil the requirements for admission to the selected medical school, and the work as arranged occupies about two and a half years of the college course. It is taken with the usual classical subjects leading to an A.B. degree. The remaining year and a half are carefully directed toward medicine by filling them with biology!

Those of us who have recollections of our college ideas of medical study will agree that there was a mysterious omnipresent picture of human dissection which occupied the entire foreground of our conception, and behind it, rather remote, a surgical background which we might some day reach. Elementary biology with its varied dissections of lower forms fitted the picture beautifully, as did histology, embryology and finally text-book courses in human anatomy and physiology. The prospective medical student finds such courses very pleasant. They are not difficult. He works much harder upon them than upon his

other studies and his success confirms him in his belief that medicine is his proper career. I know that courses in experimental biology and plant physiology are offered, which demand the immediate use and observation of physico-chemical facts. It might be maintained that such work is very direct and valuable training for medicine but I can not agree with such an attitude unless the courses in question are preceded by more fundamental physics, chemistry and physical chemistry than is now required for medical school admission. Experimental biological courses of this type do not, in my experience, reach many men. The majority have been concerned with what amounts to elementary comparative anatomy and histology, work which meets the needs neither of medicine nor of the medical school and which, though it has an educational value of high order, does not lead to the definite scientific specialization which modern medicine demands. A medical student of to-day must have a larger understanding of physics, of chemistry, and of mathematics than is pictured in the admission requirements of the school catalogues.

It is interesting to many who have had a close view of medical education and who have observed the direction of medical school development since the four-year course became general, to follow the gradual absorption of hours which had been given to different branches of anatomy, by physiological chemistry, physiology and pharmacology. The day when anatomy was the only real laboratory study is long past, and it is perhaps not an extreme view to hold that gross morbid anatomy —dissection—will be still further cut in many schools during the next ten years.

While this fact is part of the ordinary observation of all who have a historical view of the gradual stuffing and squeezing of the medical course, it has evidently not become a possession of the average college adviser who directs the student to the very door of medicine. He has a keen recollection of the struggles of his own contemporaries as they plunged along through a solid old Scotch course in gross anatomy and he thinks that every medical student must prepare for the same fate. It is true that a thorough course in comparative anatomy together with such desultory work in human anatomy as college courses offer, and, indeed, all biological studies, may make a man somewhat more efficient in his medical anatomical course. But the trouble is that the medical schedules have changed and anatomy now takes at best a quarter instead of almost the entire working laboratory time. The student prepared as I have outlined, and it is the usual preparation, finds and readily acknowledges that he has taken the correct path to equip himself for a career in anatomy if he wishes to specialize in this subject, but he finds too that he has been thoroughly cursed by wasted hours if he heads out into the many other fields which make up medicine.

I may seem to have indicated a belief that human physiology and human anatomy have no place in the college course, but this is not my intention. There can be no doubt that the more widely these subjects are taught the better. Let them be emphasized increasingly for all who are not to study medicine. The prospective medical student, however, must lay his lines in harder places.

In my experience there are not many men, who at the end of their first two medical school years, look upon anatomy as their most difficult course. True, it may have required more hours of study than any other subject, but this was due rather to bulkiness than to the character of the work. Just as in college the ordinary man regards biology as easier than physics, so in the medical school, the average student finds the purely observational task which anatomy represents far easier than physiology or physiological chemistry. Certainly with the steady encroachment of physico-chemical material it is only a matter of a very short time when this statement will be true with even greater emphasis than it is to-day. There is only one line of safety, then, for the man who plans to take medicine. He must prepare on the side of physics and chemistry, taking as much of these two subjects as his college course will permit. He will naturally take enough mathematics to keep

abreast of his progress in physics. It is by these three staunch aids alone that the trio of physiology, physiological chemistry and pharmacology may be successfully faced.

It may be objected that the man who sacrifices his biological training—and by this I mean takes no more than the present minimum required by the medical school of his selection—while he may find himself in better shape for physiology, etc., will not be better off in his medicine and surgery later on. By the same voice we shall hear that *general practise* does not need this scientific underpinning. I do not know what the training of that vague person, the "practical family doctor," should be, but I do know that he will make poor shift to graduate well from the modern medical school unless he heed his early training, and poorer shift still to keep up with current medical literature later on if he has failed to appreciate the direction in which medicine is growing.

The constant establishment of surgical and medical research laboratories with the consequent injection of scientific methods into the practical branches, is a matter of general comment, and emphasizes the large influences which are shaping medicine into a science. It is possible that most men who advise college premedical students are somewhat aware of the facts which I have tried to bring out in this paper, but feel strongly that such early and emphatic specialization as has been advocated may have a narrowing influence. If this be their attitude they are not consistent in permitting wide excursion into anatomical biology with the idea of better equipment for medicine later on, and it is against the futility of such a course that I protest.

It is often hard to point out to students the utility of subjects, essentially somewhat abstract, in their relation to medicine. This is especially true when one is confronted by the fact that medical school catalogues do not advise the prospective student to fulfil the given requirements, and then if possible to extend his course in the directions I have indicated. Yet there is no doubt that the man well grounded in these fundamental subjects, which become very inaccessible after the medical school is once entered, possesses an advantage over his less fortunate fellows which can be turned to most vivid and permanent account.

Cecil K. Drinker

Department of Physiology,
Harvard Medical School

THE AURORAL DISPLAY OF AUGUST 26

To the Editor of Science: The notes by Dr. Nutting and others in Science on the Aurora of August 26 have been read with much interest by the writer. None of these, however, mentions the appearance of this phenomenon from a point as far south as Washington. On the evening in question, I was sitting on the front porch (facing north) of my residence here. It had been quite a warm day and in the north was a heavy bank of clouds in which lightning had been playing all through the twilight and early evening; the sunset glow seemed to be unduly prolonged back of this bank of clouds. My attention was first called to what I took to be a small, faintly luminous cloud, about the shape of a mirror image of the map of Nevada, which covered a portion of the constellation of the Great Dipper. The length of this supposed cloud was about equal to that of the handle of the Dipper, with the longer axis at right angles to the handle. After persisting for some time this little patch moved away rather rapidly to the west and disappeared, only to reappear in its original position after the lapse of several minutes. Meanwhile, the seemingly prolonged sunset glow above the bank of clouds in the north had become a fringe of pale steady light, apparently extending out over the edge of the cloud a considerable distance. While the small patch of light over the Dipper soon disappeared again, the glow back of the cloud bank persisted for a long time. No distinct color was observed, the light being a uniform faint white; no streaming or other movement was observed, except that of the small patch of light already described.

F. Alex. McDermott

Washington, D. C.,
October 26

THE auroral display of August 26 described by Professor Nutting and others in recent numbers of SCIENCE, I observed from Lucasville, 10 miles north of the Ohio River in Scioto County, Ohio. This is in practically the same latitude as Washington and much farther south than the observations recorded to date of writing. It took the form of a bright, white, uniform illumination of the entire northern heavens, which extended in decreasing intensity almost to the zenith. Although watched intermittently for about an hour between 8.30 and 9.30 o'clock, no color bands, streamers, curtains, moving light waves, pulsations or other phenomena were observed, nor was any tendency to increase or diminish in brightness detected.

The same display was witnessed by many lake-shore campers at Cleveland, and was noted by Cleveland papers the next day. The diffused character of the light over the lake and its greenish color were particularly noted.

J. E. HYDE

WESTERN RESERVE UNIVERSITY

TO THE EDITOR OF SCIENCE: In connection with Professor Nutting's vivid account in a recent number of SCIENCE (p. 496) of a remarkable auroral display witnessed by him at Lake Douglas, Michigan, it is perhaps of interest to record that the same or a similar display was observed that identical evening in a region as remote as the Glacier National Park, Montana.

At about 10: P.M., August 26, while Mr. E. H. Dole and myself were returning from the Many Glacier Hotel to the nearby Teepee Camp on Lake McDermott, our attention was attracted by a peculiar bright glow quite low on the horizon in the eastern sky, as though from the lights of a great city. We were much puzzled by it until we had emerged far enough from the disturbing glare of the electric lights to discover that a similar, though weaker glow was in the west, and indeed that an evanescent shimmering arch of light extended not only clear above us, but well past the zenith into the southern sector of the heavens. Unfortunately our view to the north was effectually obstructed by the gloomy bulk of Altyn Peak and the canyon wall, but by this time the auroral nature of the phenomena was evident to us. While too shut in by the narrow valley to secure the full enjoyment of the display which so enthralled Professor Nutting, that which we saw seemed sufficiently remarkable. The light extended over the sky and seemingly diffused through the whole upper atmosphere in so general a glow that here also its real brilliance was difficult to appreciate. Quavering streams of light—an everchanging sheen, sometimes brighter here, sometimes brighter there —never uniform—no simile could be more delightfully suggestive than Professor Nutting's allusion to the photogenic play of the meridional bands of Ctenophores as seen in darkened water. The same comparison forced itself into my own mind at the time.

S. STILLMAN BERRY

REDLANDS, CALIFORNIA,
October 19

TO THE EDITOR OF SCIENCE: I was much interested to read in the current number (October 20) of SCIENCE the records of places at which the auroral display of August 26, 1916, was seen. All five of the notes in this issue report observation of the display at points to the east and northeast of the locality reported by Professor Nutting in SCIENCE of October 6.

Following the suggestion of Professor Baker, I wish to record having observed the same phenomenon during the same evening at Amery, Wis., fifty miles northeast of St. Paul, Minn. The same remarkable features so well described by several writers were in evidence— the ever-changing, ebbing and swelling pulsations and the shimmering streamers of light, fading and intensifying at the same time in different parts of the heavens—but no marked exhibition of color so far as noticed. The center of the display was near the zenith and practically the whole sky was occupied except at times a rather narrow indefinite band or strip in the south.

Mr. Paul B. Sears, also a member of this department, informs me that on the same night he observed the display at Madison in northeastern Nebraska. The phenomenon exhibited

practically the same features in this locality as in Wisconsin and Michigan.

This information may be of interest as extending considerably the recorded area over which the display was visible.

WILMER G. STOVER

OHIO STATE UNIVERSITY,
October 24

TO THE EDITOR OF SCIENCE: I have been greatly interested in the descriptions of the auroral display of August 26, and would like to add a word to what you have already published. I observed the phenomenon at Ephraim, in Door County, Wisconsin, between ten o'clock and midnight; other observers at the same place reported to me that it lasted until long after midnight. The description of the display as given by your contributors corresponds in the main with my own observation, but with one difference: I saw two distinct color regions in addition to the white pulsation described by all the others. At the zenith the color was white, but in the east there was a region that changed several times from pure white to a brilliant rose color, while in the north there were streamers of delicate green. The universal, shadowless illumination was very remarkable, as was also the display in the southern sky, where the streamers reached almost to the horizon.

JOHN C. HESSLER

THE JAMES MILLIKIN UNIVERSITY
October 21

TO THE EDITOR OF SCIENCE: I have been interested in the reports of the auroral display of last August, by Professor Nutting and others. The aurora was seen with all the brilliancy and variation of colors described by Professor Nutting, at Lake Minnetonka, near Minneapolis, Minn., on the 26th of August.

We were out in a boat, and, when well out in the lake, there appeared what at first seemed to be the glow thrown on the eastern sky by a fire. The light was not as red as that produced by a fire, and there were no clouds in the sky where the light first appeared. As we watched it, it soon became evident that the light was not from a fire but that of an aurora.

It appeared a little to the north of east down near the horizon, gradually rising and forming an arch across the northern sky a little higher than is usual for auroras in Minnesota. Then another band appeared below the first and lower down in the north. These bands were not as definite as in most of the auroras that I have seen in Minnesota, nor did they show the vertical bands of light, but the diffuse light seemed concentrated in these two regions.

Then more rapidly the light mounted upwards and as it reached almost to the zenith there suddenly was formed what seemed a vortex of scintillating iridescent light. Pausing here for a moment the light continued to extend on to the southern half of the sky until it reached nearly half way to the southern horizon, or until nearly all of the sky was lighted with this constantly changing light in bands, and areas.

The rapidity of change both in distribution as well as in color of the light was fully as marked as that described by Professor Nutting.

We watched the display until ten o'clock, and others said that it was even more brilliant later.

H. B. LATIMER

UNIVERSITY OF NEBRASKA,
October 23

TO THE EDITOR OF SCIENCE: Among the reports on the unusual auroral display of August 26, I see none from farther west than Michigan. It might be of interest to readers of SCIENCE to know that this display was visible in all its splendor at Winton, Minnesota, north of Duluth, and was very much as described by Professor Nutting, except for the lack of color which he describes.

R. R. HUDELSON

UNIVERSITY OF MISSOURI,
October 26

TO THE EDITOR OF SCIENCE: Unfortunately, I was not further west than Brainerd, Minnesota, on August 26, but that is in the same latitude and five hundred miles west of Lake Douglas, in Michigan, where Professor Nutting saw the auroral display. These displays are common occurrences in the wintry months in this locality, often being brilliant, but in

recent years none compared with this one. Together several of us observed it until almost twelve o'clock, but its greatest brilliancy and intensity was seen before eleven. Among the striking things was the rapidity of the movements, the brilliancy at the zenith, and the distance to which the bands of light extended into the south. It seemed as though the light originated near us, so bright was the display at the horizon in the north. The color was variable from light-green to light-yellow and gray.

CARL ZAPFFE
BRAINERD, MINN.,
October 25

TO THE EDITOR OF SCIENCE: Since the accounts of the aurora of August 26 in SCIENCE for October 6 and 20 covered only an area from Michigan eastward, it will be of interest to know that it was observed at least as far west as the Front Range of the Rockies in northern Montana. We were camped at the time a few miles east of the old postoffice of Saypo or west of Chateau in Teton County, some eight miles east of the mountain front. The phenomena here were very much like those described by others. I give them from memory.

As the brilliant, yellow, diffused light of sunset faded in an absolutely cloudless sky, an arch of white light became visible extending across the sky from east to west, perhaps 60° from the northern horizon. North of this were three or four broad vertical bands of white, the lower ends somewhat fringed as they are so often shown in illustrations, but I noticed no streamer-like motion. The arch slowly moved southward, mounting in the sky. Between nine and nearly eleven I saw nothing further of the aurora, but when we looked at it again, shortly before eleven the east and west arch was only some 20°–30° above the south horizon and all the rest of the sky to the north of it was aflame with white lights, which, as I remember it, waved and flickered irregularly, but incessantly from all sides towards the zenith. A few minutes later all traces of the auroral glow seemed to have disappeared.

Though I saw only white lights myself, some people whom we spoke to next day mentioned a pink glow.

MARCUS I. GOLDMAN
U. S. GEOLOGICAL SURVEY,
WASHINGTON, D. C.,
October 31

TO THE EDITOR OF SCIENCE: It is interesting to note that the auroral display of August 26 was visible in southwestern Montana. Owing to the prevailing atmospheric conditions it appeared to be of a different character there. The writer and a companion, being engaged in geologic work in the Beartooth Mountains under the direction of the University of Chicago, were at that time camped just below the rim of one of the high plateaus on the northeastern side of the range, at an elevation of about 9,500 feet. The most violent thunderstorm of the season had swept over the plateau the previous evening. In the morning great banks of fog rolled up from the canyons, completely hiding the plateau for the greater part of the day. Toward evening the fog lifted slightly, and about nine o'clock a luminous rosy light was noticed in the northeast. It was a steady glow that spread from the horizon, which was quite high, far up in the sky. No streaks or shafts of light of any sort were seen during the half hour that the light was observed.

A feature of the occurrence as viewed in that locality, which has not been reported elsewhere, was the repetition of the phenomenon on the following evening, but on a much smaller scale. From the bottom of the canyon a faint glow was seen over the rim of the plateau, but it was observed for a short time only.

ARTHUR BEVAN
UNIVERSITY OF CHICAGO,
October 30

TO THE EDITOR OF SCIENCE: The auroral display of August 26, first described in your columns by Professor C. C. Nutting, was also observed from the Columbia River Gorge, forty-five miles east of Portland. I was a member of a party of geology students from the University of Chicago and on the night of the display our camp was located on the north side of the river at Collins, Washing-

ton. The light first appeared from the northeast in the form of a brilliant belt of pearly white, the rays of which seemed to converge toward a center somewhat below the horizon. It became so intense and the direction of the belt shifted in such a fashion that some members of the party at once thought it was the headlight of a train approaching around a curve. In a very few minutes the display changed to a brilliant array of streamers with intermediate belts of diffused light, all of which seemed to diverge from a common center. At this stage it resembled very much the corona type of aurora, with the exception that the streamers reached almost to the zenith. The intensity of the light and the position of the streamers were constantly changing, but the source from which they seemed to diverge remained fixed for almost half an hour. Finally this aspect of the display vanished, and there appeared a broad band of diffused light that began swinging across the heavens from the original position in the northeast to an east-west position and extending from the eastern horizon through the zenith almost to the western horizon where it faded out. It remained fixed in this position for at least fifteen minutes, during which time it gradually narrowed and grew in intensity until its width might well be compared to that of a rainbow and its brilliance became more striking than ever. At length it began to fade away and finally disappeared. At no time did we observe the coloring described by Professor Nutting. The phenomenon first appeared between nine and ten o'clock Pacific Standard time, which was not very far in absolute time from that of Professor Nutting's observation in northern Michigan.

W. L. Foster

University of Chicago,
November 2

On August 26 I was in camp with Dr. Walcott at Hector, a station on the Canadian Pacific Railway, practically on the divide of the Rocky Mountains in British Columbia.

The view northward is limited by a mountain ridge two thousand feet or more above the camp. Mountain masses are not far distant to the southeast and southwest, but to the east, south and west the view is quite extensive.

At 8:40 P.M. (two hours slower than eastern time) a faint "curtain" of light appeared in the northeast, well above the mountain. Immediately afterward this was extended by waving columns of light to the eastward and westward: then a veritable "glory" appeared spreading across the northern hemisphere. Long beams of light as though from huge searchlights flamed across the sky, curtains and bands formed in swaying folds. A little later, about nine o'clock, the whole heavens were included, with rays extending from the zenith to the horizon (as limited by the topographic features).

There seemed to be a shower of light surrounding us, which gradually faded. Up to this time the light was white or very pale green in places. Immediately followed a gorgeous display of colored lights, reds, greens, blues, more nearly in the north. In the whole display the motion of light was from east to west.

R. H. Chapman

Washington, D. C.

To the Editor of Science: It may interest the readers of Science to know that the auroral display of August 26, which has already been extensively commented upon in these columns, was visible in the Selkirk Mountains in British Columbia, upwards of three thousand miles west of the extreme easternmost locality in Nova Scotia reported by Professor Heyl. Auroral displays are not infrequent during the summer months in the Selkirk Range, but the one in question was the most brilliant, and otherwise the most remarkable, of all that I have seen in this region during an experience covering the greater part of six summers. It may, or may not, be of significance that it came shortly before a period of twelve consecutive rainy days, during which thunderstorms—usually relatively rare in the Selkirks—were both numerous and violent, and severe hail-storms also occurred

over a wide area. Miners in this part of British Columbia believe that in the winter a particularly brilliant display of the aurora is likely to be followed by a heavy fall of snow, but I am unable to determine how far the actual records bear out this belief.

M. H. Jacobs
University of Pennsylvania

SCIENTIFIC BOOKS

The Life of Inland Waters. An elementary text-book of fresh-water biology for American students. By James G. Needham, Professor of Limnology in Cornell University, and J. T. Lloyd, Instructor in Limnology in Cornell University. Octavo of 438 pages with 244 illustrations. 1916. The Comstock Publishing Company, Ithaca, New York.

Needham and Lloyd have produced a very good and very useful book. It is well planned, well executed and well illustrated. It deals with the life of fresh water—chiefly the microscopic forms and the insects—from the point of view of environment and mutual adjustment. It is, therefore, not a handbook for identifying forms, nor is it a treatise on limnology and its methods, or even on fresh-water biology. It is not a "popular" book, to be read with full intelligence and interest by a person ignorant of biology and of fresh-water life in particular. It is rather a book to accompany the study of fresh-water biology in laboratory and in the field. It gives the general points of view, the grouping and correlation of facts, which such a student needs if he is not to become entangled in a hopeless web of details. This it does in moderate compass and with sufficient detail to make the principles clear, definite, and, therefore, useful to the student.

The subject is handled under four main heads: (1) the nature and the types of aquatic environment; (2) aquatic plants and animals; (3) adjustment of plants and animals to conditions of aquatic life and to each other in aquatic societies; (4) inland water culture. The reviewer finds the fourth head the least interesting, though not the least important from a practical point of view. Less has been done and, therefore, there is less to be said about this matter as yet. The third head (Chapters V. and VI.) shows the book at its best. The interrelation of plants and animals and the adjustment of both to environment are here discussed. Chapter V., for instance, treats first of individual adjustment to aquatic life, whether in open water or on the bottom. Methods of floating, swimming, etc., are described for the open-water forms, and methods of burrowing, shelter building, motion on and through the mud, etc., for the bottom forms. Adjustment of the life cycle to seasonal changes in the aquatic environment is then considered, involving such matters as statoblasts and winter eggs. Mutual adjustment is briefly treated and illustrated by the insectivorous marsh plants and by the larval habits of mussels. Chapter VI. deals, first, with limnetic societies, primarily divided into those of open water and those of the shores. The former includes the plankton (persistently spelled "plancton" by the authors—doubtless with reformers' intentions); the latter set includes the shallow-water societies passing into those of ponds, pools and marshes. The chapter concludes with an account of the lotic societies, or those of streams. All of these forms of association are well described and especially well illustrated.

Of course any specialist will see places where he would have written the book differently, and places where he would have enlarged or reduced the space given by the authors. One must regret that the fascinating and valuable subject of mutual adjustment is so briefly treated. The emphasis on insects will seem somewhat disproportionately large to students of other groups. It seems to the present reviewer that the account of physical conditions of life in lakes has not the vigor of the ecological chapters. Here and there the subject is somewhat fumbled, as in the treatment of lake temperatures. The summer temperature conditions of Cayuga Lake, shown in

Fig. 4, are very different from those shown in Fig. 5. The latter figure plainly does not come from observations in the open lake. This can not fall to 4° by December 1; nor can the surface maintain a temperature of nearly 30° in July. The discussion of the thermocline shows that the authors' interests are primarily elsewhere than with temperatures.

But such matters do not detract from the general value of the book, both for students and as a contribution to limnology.

A word must be said of the illustrations which, in general, are extraordinarily good. Sometimes photography is pushed too far. Not a few photographs of insects, etc., are from objects so dark that they do not show necessary detail. In such cases a drawing would do much better service. But a great many of the photographs, such as Fig. 61—duck-meat—and Fig. 207 really illustrate the subject and tell the student in the study what he ought to see in the field.

E. A. Birge

Individuality in Organisms. By Charles Manning Child, Professor of Zoology in the University of Chicago. The University of Chicago Press, 1915. Pp. 213. $1.25 net.

What is the nature of the unity and order which characterize the organic individual? Upon the basis of fifteen years of experimental and analytical investigation Professor Child in his recent book on "Individuality in Organisms" attempts to give an answer to this important problem.

In the first chapter of the book the writer makes clear that he is dealing with the problem of physiological individuality exclusively without metaphysical assumptions. Current hypotheses of the individual are found either to ignore the problem of the unity and order within the organism, or they carry with them vitalistic implications. His criticism of these hypotheses in chapter two forms one of the most readable portions of the book.

In place of current "corpuscular" theories of the individual which postulate "a mysterious, self-determined organization in the protoplasm, cell or cell-mass," Professor Child would substitute a dynamic conception of the individual. Physiological unity and order in his opinion are to be interpreted not in terms of a hypothetical organization and the transportation of chemical substances within the organism, but in terms of differences in the rate of reaction and of transmitted change. The basis of individuality lies in "spatial quantitative differences in the action of external factors on protoplasm." He finds experimentally that the head of the animal and the growing tip of the plant are centers of more active metabolism while posteriorly or basally processes are less intense. This evidence has led him to his doctrine of metabolic gradients, proof of the existence of which is advanced in chapter three.

Concluding that "the organic individual is fundamentally a dynamic relation of dominance and subordination, associated with and resulting from the establishment of a metabolic gradient or gradients," Dr. Child in subsequent chapters presents evidence of dominance within the organism and discusses the limitations of its range. Dominance in the individual is determined primarily, not by means of the transportation of chemical substances from one organ to another, but through the transmission of impulses just as in the nervous system. Subsequent to organic differentiation in ontogeny, however, integration of the organism may be partly effected through the transportation of chemical substances.

The bearings of the hypothesis upon the problems of differentiation, reproduction, heredity and evolution are suggested and briefly discussed in the concluding chapter of the book.

The claims of the author for his hypothesis are modest. It is certainly not too much to say that it has already proved its value as "a basis for the synthesis and ordering of many facts in various fields which heretofore have seemed to have little or nothing in common" and that it has brought "certain aspects of biology within hailing distance of physicochemical conceptions." Adverse criticism has been largely forestalled by the objections which Dr. Child has himself raised and an-

swered, and by his resourcefulness in experimental verification.

The theory seems less satisfactory in its application to the phenomena of gametic reproduction than to the processes of regeneration. Pushed to its logical extreme in its application to ontogenesis the process of individuation postulated by Child appears to be one of complete epigenesis and the organization which develops to be due exclusively to external factors. In order to meet the insuperable difficulties which would be raised against a consistent theory of epigenesis, Dr. Child assumes that as a result of the influence of external conditions through many generations and through the inheritance of the acquired modifications, reproductive cells or cell-masses have come to possess "a fundamental reaction system" which constitutes a basis of preformation and conditions their development and their reaction to external stimuli. In this way it is possible to understand why under similar external conditions the ontogenesis of different species varies so greatly. Moreover, the "fundamental reaction systems" may be further modified through their intra-individual environment.

In order to meet the difficulty of understanding how a "reaction system" involving primarily only quantitative dynamic differences determines specific qualitative differences which appear in ontogeny, Dr. Child is led to assume primary differences in the specific constitution of the protoplasm of different eggs or cell-masses. But, since "systems" suggest spatial localization and the "specific constitution of protoplasm" implies chemical differentiation, does it not seem as if the basis of individuality postulated by Dr. Child is essentially like that assumed in the hypotheses which Dr. Child repudiates? On the whole, however, Dr. Child's hypothesis of individuality appears to be the best supported and the most consistent mechanistic hypothesis which has been advanced.

As the product of the mature thought of an independent and resourceful investigator "Individuality in Organisms" will take a permanent place in biological literature.

H. V. NEAL

PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES

THE tenth number of Volume 2 of the *Proceedings of the National Academy of Sciences* contains the following articles:

Preliminary Results on the Color of Nebulæ: F. H. Seares, Mount Wilson Solar Observatory, Carnegie Institution of Washington. Photographs of a Messier 51, 94, 99 show that the nebular condensations have large negative color indices. The knots of nebulosity are bluer than the bluest of the neighboring stars. The spectral character of the outlying regions differs from that of the central nucleus. In the case of the planetary nebula N. G. C. 3242 no important differences of this sort are revealed.

The Action of Alkali in the Production of Lipolytically Active Protein: K. George Falk, Harriman Research Laboratory, Roosevelt Hospital, New York. The author discusses: Inactivation of the enzymes by acid, by alkali, by alcohols, by acetone, by salts and by heat; nature of the chemical changes involved in the inactivations; and activation of proteins by alkali.

The Excretion of Acids by Roots: A. R. Haas, Laboratory of Plant Physiology, Harvard University. The author finds that no acid other than carbonic was excreted from the roots of corn seedlings. Similar results were obtained for wheat seedlings.

Spectrographic Observations of Relative Motions in the Planetary Nebulæ: W. W. Campbell and J. H. Moore, Lick Observatory, University of California. Further observations indicating the probability of the hypothesis that the so-called ring nebulæ are in reality not ring forms, but ellipsoidal shells. Tentative conclusions are also drawn as to the probable masses of the nebulæ.

New Determinations of Permeability: S. C. Brooks, Laboratory of Plant Physiology, Harvard University. The determinations have been made by a new independent method and by improved older methods. The results agree in showing that living protoplasms are normally permeable to the salts studied, but salts of pure solutions may alter permeability, some causing an increase of permeability while

others cause a decrease, followed by an increase, of permeability. In a properly balanced solution the permeability remains normal. Cell walls may be semipermeable to an extent which renders them important in such experiments.

Point Sets and Cremona Groups. Part III.: Arthur A. Coble, Department of Mathematics, Johns Hopkins University. The group $G^2_{6,2}$ is used in the problem of determining the lines of a cubic surface. The determination differs from that of Klein.

The Interferences of Spectra both reversed and inverted: Carl Barus, Department of Physics, Brown University.

Sex Intergrades in a Species of Crustacea: Arthur M. Banta, Station for Experimental Evolution, Carnegie Institution of Washington. The author has collected a large amount of data on several species of Cladocera which is interesting because of the remarkable array of sex forms, the stock in general consisting of perhaps 40 per cent. normal males and about 8 per cent. normal females, the remainder being intergrades with *almost* every combination of sex characters.

Some Problems of Diophantine Approximation a Remarkable Trigonometrical Series: G. H. Hardy and J. E. Littlewood, Trinity College, Cambridge, England. A series is given which is never convergent or summable for any value of θ, and is accordingly not a Fourier's series. And further a function is found which does not possess a finite differential coefficient for any value of θ.

Steric Hindrance and the Existence of Odd Molecules (Free Radicals): Gilbert N. Lewis, Chemical Laboratory, University of California. It is contended that the hypothesis underlying the somewhat elusive phrase "steric hindrance" should not be introduced until phenomena are known which can not be so well explained in other ways. It is shown how the so-called free radical of organic chemistry may be explained independently of the hypothesis of steric hindrance.

Newton's Method in General Analysis: Albert A. Bennett, Department of Mathematics, Princeton University. An extension to general analyses of special algebraic work of H. B. Fine.

The Cobaltammines: William D. Harkins, R. E. Hall and W. A. Roberts, Kent Chemical Laboratory, University of Chicago. The authors have determined accurately the freezing-point lowerings caused by eight different cobaltammine salts, and have derived from the results the number of ions into which each salt dissociates. These are found to be in accordance with Werner's theory.

National Research Council: Report of the First Meeting of the Council. Reports of meetings of the Executive Committee. Organization of the Research Council (as at present constituted).

EDWIN BIDWELL WILSON
MASSACHUSETTS INSTITUTE OF TECHNOLOGY,
CAMBRIDGE, MASS.

THE AURIFEROUS GRAVELS OF THE SIERRA NEVADA

THE origin and the natural distribution of the $300,000,000 of gold that has been mined from the Tertiary placer gravels of the Sierra Nevada of California is the subject of a report by Waldemar Lindgren, which has been published by the United States Geological Survey as Professional Paper 73.

The Geological Survey's studies of the Tertiary placer deposits of the California Sierra began in 1886 and were concluded about 15 years later. During this period 22 quadrangular areas were topographically mapped and 14 of these were studied in geologic detail and the results published by the survey in geologic folios. Professional Paper 73 includes the salient features of this earlier work, most of which was done by Mr. Lindgren himself. This report, thus comprehensive in geographic scope and minute in geologic detail, is believed to be the most complete and thorough description of a great placer-gold province ever published.

In the main the report is a detailed description of the entire area covered, including the gold placer gravels, but Mr. Lindgren's general account of the tremendous earth forces that built up the Sierra and of the processes

that freed the gold from its mother rock and brought about its concentration in prehistoric river channels forms altogether a most impressive description of continent building. Looking backward through inconceivably long vistas of time in which periods covering millions of years supplant the centuries by which we now compute its passage, the geologist pictures the uplift of the new-born mountain range by upward-forced great bodies of molten granite. This uplift was accompanied or closely followed by the formation of veins and seams of gold-bearing quartz, and the resulting highland was then planed down by erosion caused by rainfall and the action of streams of water.

Tracing the long course of this early history the geologist now finds that toward the end of what is known as Tertiary time—a comparatively recent geologic period—volcanic forces that had long been quiescent vigorously reasserted themselves. Flows of rhyolite, a volcanic rock, pouring from many craters, filled valleys that were covered with gold-bearing gravel, deeply burying the gold and causing the formation of new stream courses.

The geologic events thus outlined long preceded the period of human history in which these metal deposits were mined. In 1849 an army of gold seekers invaded the Sierra. They worked first along the present streams, but gradually the metal was traced to the old Tertiary river beds on the summits of the ridges and to the quartz veins, the primary source of all the gold in the Sierra Nevada. Millions of dollars in gold were produced annually up to the seventies of the last century, but the gold-mining industry has slowly diminished, until now less than $1,000,000 is produced annually, the decline being due to the prohibition of hydraulic mining and the exhaustion of the richer channels suitable for drift mining.

The total output of gold in California is estimated at $1,200,000,000 to $1,500,000,000, about one fifth of which has been derived from quartz veins, $300,000,000 from the Tertiary gravels, and the remainder from the Quaternary deposits.

SPECIAL ARTICLES

ON THE DIFFERENTIAL EFFECT OF CERTAIN CALCIUM SALTS UPON THE RATE OF GROWTH OF THE TWO SEXES OF THE DOMESTIC FOWL[1]

IN connection with an extensive series of experiments on the effect of feeding various organ substances to growing chicks, which I have been carrying out during the past summer with the aid of Mr. W. T. Pettey, two groups were given small daily doses (Ca. 0.1 gm. to 0.3 gm.) of calcium lactate ($Ca(C_3H_5O_3)_2 + 5H_2O$) and calcium lactophosphate (a mixture of calcium lactate and calcium phosphate containing about 3 per cent. of the latter), respectively. The results were consistent, striking, and in certain particulars entirely new. A complete account of them, with detailed figures, will be published as soon as the material can be prepared for the press. In the meantime I wish to call attention, in a very brief way, to the essential features of the results. The most significant finding is that while neither of these calcium salts affects in any way, in the dosage used, the rate or amount of growth *in the male chicks*, both of them, but particularly the lactophosphate, induce a very marked increase in the absolute amount of growth and a corresponding acceleration in its rate *in the female chicks*. The dosage was begun when the birds were 29 days of age and continued until they were 171 days old, after which age there is comparatively little additional growth in the domestic fowl. At the end of this 142-day period the lactophosphate females had grown so much faster than the control females that there had been eliminated 58.4 per cent. of the normal difference between the sexes in respect to body weight (secondary sexual character). In spite of the rather large probable errors the absolute differences are statistically significant. Thus we have at 171 days of age:

$$\text{Lactophosphate ♀♀ mean wt.} - \text{Control ♀♀ mean wt.} = 354.6 \pm 91.9 \text{ gm.}$$

The difference is 3.85 times its probable error.

The reproductive organs of the females were stimulated as well as growth. The rate of

[1] Papers from the Biological Laboratory of the Maine Agricultural Experiment Station, No. 104.

egg production per unit of time in the lactophosphate females is nearly 5 times as great as in the controls.

A further point of interest is that if a very small dose of corpus luteum substance[2] be administered to the birds each day along with the calcium lactophosphate the stimulating effect of the latter upon the growth of the females is completely inhibited.

It has been known that the internal secretions of certain organs might have a different effect upon the growth of males and females, and indeed in the present series of experiments we have seen such a differential effect following the feeding of several different gland substances. It is another thing, however, to find inorganic salts exercising such a differential effect. It furnishes one more piece of evidence of the deep-seated biochemical differences which underlie sex differences, and at the same time is in line with the medical evidence as to the great importance of calcium in the physiology of the reproductive organs of the female. RAYMOND PEARL

October 31, 1916

THE PRESENT STATUS OF THE DOLOMITE PROBLEM[1]

THE problem of the origin of the dolomites and dolomitic limestones has long occupied the minds of geologists and many theories have been advanced for their formation. But no one of these has been universally accepted. The chief theories which have been proposed are briefly as follows: First, the alteration theories which assume that dolomites have been formed by the partial replacement of limestones by magnesia either (1) before they emerged from the sea, through the agency of sea-water, or (2) subsequent to their emergence through the agency of ground-water. Second, the primary deposition theories which maintain that the dolomites were originally deposited in the form that they now appear, (1) by chemical precipitation from the sea, or (2) by the deposition of clastic grains of dolomite derived from the disintegration of older dolomitic limestones. Third, the leaching theories which are based on the well-known fact that during the weathering of a dolomitic limestone the lime is removed more rapidly than the magnesia, thereby causing an enrichment of the latter constituent. This leaching is supposed to take place either (1) through the agency of sea-water prior to emergence, or (2) through the agency of atmospheric water after the limestone has become a part of the land.

The marine alteration theory is by far the most widely held to-day, but the chemical precipitation theory has many champions.

The writer was led to suspect several years ago, that a careful field study of dolomitic formations would throw some light upon their origin and through the aid of the Iowa Geological Survey and an appropriation from the Esther Herrman Research Fund of the New York Academy of Sciences he has been able to examine nearly all of the important dolomites of the Mississippi Valley and the eastern United States.

These studies have furnished irrefutable evidence that the majority of the dolomites examined have resulted from the alteration of limestone. The following facts support this contention: (1) the lateral gradation of beds of dolomite into limestone, sometimes very abruptly; (2) the mottling of limestones on the border of dolomite masses by irregular patches of dolomite; (3) the existence of remnants of unaltered limestone in dolomite, and of nests of dolomite in limestone; (4) the irregular boundaries between certain beds of limestone and dolomite; (5) the presence of altered oolites in some dolomites; (6) the protective effect of shale beds; and (7) the partial obliteration of original structures and textures in many dolomites and dolomitic limestones.

Concerning the conditions under which the dolomitization took place there are many reasons for believing that the more extensive dolomites have all been formed beneath the sea prior to or contemporaneously with recrystallization and that the dolomitiza-

[2] A material which I have earlier shown (*Jour. Biol. Chem.*, Vol. XXIV., pp. 123–135, 1916) to have a retarding or inhibiting effect upon the growth of the chick.

[1] A more complete report on the origin of dolomite will appear in Vol. XXV. of the Iowa Geological Survey, which is now in press.

tion produced by ground-water is only local and very imperfect. Some of the features which lend weight to this view are as follows: (1) Recent dolomitized coral reefs are known to have been formed by the reaction of the magnesia of sea-water with the limestone. (2) The dolomite areas of mottled limestones are believed to have undergone recrystallization at the same time as the associated limestone areas, as suggested by the occasional development of zonal growths of calcite and dolomite. (3) In imperfectly altered limestones the dolomite is seen to follow original lines of weakness rather than secondary structures, such as joints or fractures. (4) In most cases of mottling the dolomitization appears to have progressed uniformly as we should expect it to do in an unrecrystallized rock, rather than to have progressed by forming veinlets and stringers in the early stages. (5) The existence of perfect rhombs of dolomite in many imperfectly altered limestones suggests that the latter had not yet solidified when the dolomite rhombs were formed. (6) The widespread extent and nearly uniform composition of many dolomites indicates that they must have been formed by an agent capable of operating uniformly over wide areas. (7) An adequate source of magnesia for transforming extensive limestone formations into dolomite is found only in the sea, which contains many times as much of the constituent as ordinary ground-water. (8) Many dolomites are directly and regularly overlain by pure limestone formations or by thick shale beds, proving that they must have been formed before these overlying beds were deposited and that descending ground-water has not been influential in their production.

The evidence of dolomitization beneath the sea then must be considered as positive, but the controlling factors of the process are very imperfectly understood, due chiefly to the lack of careful study of the phenomenon in the modern seas. A thorough investigation of the conditions which favor the transformation in the sea to-day would be invaluable in interpreting the history of the ancient dolomites. It is believed that very important data bearing on the problem could be obtained from a more careful study of the coral islands of the Southern Pacific.

As to whether dolomitization takes place in concentrated seas or not there has been considerable disagreement. Until recently the tendency has been to follow Dana, who believed that dolomitized portions of recent coral reefs were formed in concentrated lagoons and assumed that the ancient dolomites must have been formed under similar conditions, but Skeats pointed out in 1905[2] that the outer parts of certain fringing reefs of the South Sea Islands, which face the open ocean, are occasionally dolomitized and that the dolomitization of coral reefs is not confined to the lagoons; and Philippi[3] soon after presented evidence of recent dolomitization in the open sea. Still more recently, Blackwelder[4] has given it as his opinion that the Bighorn dolomite has resulted from the progressive alteration of limestone during deposition, the concentration of the magnesia being not more than two or three times as great as in the present ocean, since more than this amount would have been unfavorable to the life processes of the time. There are many commendable points to this theory of progressive dolomitization at low concentrations, but if dolomitization can go on under these conditions, why are not all of our limestones dolomitic? In answer to this query it might be said that the alteration takes place under unusual circumstances, possibly through the agency of certain bacteria which are not always present when limestone is deposited.[5] But much of the field evidence speaks against progressive dolomitization. The wavy boundaries sometimes exhibited between the dolomitic and non-dolomitic portions of formations; the lateral gradation of beds of dolomite into limestone; pseudo-interstratification effects of

[2] *Quart. Jour. Geol. Soc. London*, Vol. LXI., p. 97, 1905.

[3] *Neues Jahrb.*, Festband, Vol. I., 1907, p. 397.

[4] *Bull. Geol. Soc. America*, Vol. XXIV., p. 607, 1913.

[5] Both Nadson and Walther have suggested the possible influence of bacteria in dolomitization. See "Gesichte der Erde und des Lebens," p. 90.

dolomite and limestone; the presence of imperfectly dolomitized oolite beds in dolomites; the occurrence of mottled limestones grading gradually into dolomite, and many other features can only be accounted for by assuming that dolomitization took place after all of the beds involved were deposited, or at least in the closing stages of their deposition. When, however, a pure limestone member succeeds a dolomite member, known to be an alteration product, conformably, the contact line being regular and continuous over wide areas, it can not be assumed that this relationship has resulted from the alteration of the lower bed after both beds were deposited. The "Lower Buff beds" of northeastern Iowa, which consist of dolomite with occasional minute limestone remnants, are abruptly followed by the pure limestone of the "Lower Blue beds" over hundreds of square miles, the transition from one into the other taking place through only a few inches of imperfectly dolomitized limestone.

Moreover, the tendency of some limestones to be more highly dolomitic in their lower portions and to become progressively less dolomitic upwards, must also be regarded as lending support to the theory of progressive dolomitization. Orton and Peppel[6] state that the Delaware and Columbus limestones of Ohio are more dolomitic in their lower than in their upper portions.

But even if it should be positively shown that dolomitization can go on at low concentrations, all must agree that it would proceed not only much more rapidly, but also more completely at higher concentrations. With reference to the question whether the ancient seas which accomplished such extensive dolomitization were more concentrated than the modern ones or not, little can yet be said. On this point we must rely solely upon inference. Steidtmann[7] has presented evidence to show that the ancient seas were more highly magnesian than those of to-day. From independent lines of reasoning based upon paleogeographic evidence the writer is also led to believe that the magnesia content of the ancient seas may have been at least temporarily greater than at present. Let us consider the conditions obtaining in a constricted interior sea from which limestone is being deposited on a great scale. Fresh quantities of lime and magnesia and other salts are being introduced into this interior sea both by influx from the open ocean and from the streams draining the land. Now lime is constantly being depleted from this inland sea by lime-secreting organisms, while the magnesia and other salts tend to accumulate. It seems possible, then, that during a long period of limestone formation under these conditions magnesia might accumulate in considerable excess and that ere long extensive dolomitization might set in and continue until equilibrium was once more established.

Applying this theory now to the stratigraphic column, we actually find that many periods of extensive limestone formation in interior seas may be correlated with periods of extensive dolomitization. Witness the great dolomite masses of the Cambrian of the Appalachian province, and of the early Ordovician and of the Niagara.

As further evidence that the early seas which accomplished extensive dolomitization may have been temporarily concentrated, attention may be called to the fact that these seas in many instances were retreating and contracting towards the last, and that unless they were freely connected with the open ocean, evaporation under arid or semi-arid conditions might give rise to a considerable increase in salinity. Such a condition would seem to apply especially well to the Niagaran sea. Paleogeographic studies have shown that this sea became very much contracted towards the close of this epoch, and Clarke and Ruedemann[8] have concluded that the Guelph fauna must have inhabited a sea of abnormally high salinity. The latter fact considered in connection with the evidence of widespread dolomitization in the later stages of the Niagara seems significant.

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[6] Ohio Geol. Survey, 4th ser., Bull. 4, p. 165.

[7] *Jour. Geol.*, Vol. 19, pp. 323 and 392. 1911.

[8] *Mem. N. Y. State Museum*, No. 5, p. 117.

SCIENCE

FRIDAY, NOVEMBER 17, 1916

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

POPULAR SCIENCE LECTURES[1]

INTRODUCTION

AT the meeting of the council in June, 1916, representations were made by the organizing committee of Section L (Educational Science) that much less attention is given to popular lecturing now than was formerly the case; and it was suggested that efforts should be made to promote increased public interest in science by means of such lectures. The council, therefore, appointed a committee representative of all the sections of the association to institute inquiries into this subject and prepare a report upon it. Many local scientific societies, universities, university colleges and similar institutions have organized popular science lectures; and the committee has endeavored to secure the results of the experience obtained, with the object of discovering the elements of success or failure.

A schedule of twelve questions was drawn up and was widely distributed. To prevent misunderstanding, it was pointed out in an explanatory letter that the committee was concerned only with single pioneer lectures for the general public, and not with students' courses, such as are arranged by university extension authorities, the Workers' Educational Association and other organizations.

[1] Report of the Committee of the British Association for the Advancement of Science consisting of the president and general officers, Professor H. E. Armstrong, Professor W. A. Bone, Sir Edward Brabrook, Professor S. J. Chapman, Professor A. Dendy, Professor R. A. Gregory (hon. sec.), Professor W. D. Halliburton, Dr. H. S. Hele-Shaw, Professor F. Keeble, Mr. G. W. Lamplugh and Dr. E. J. Russell, appointed by the council to consider and report on the popularization of science through public lectures.

A circular containing the schedule of questions was addressed to (1) principals and registrars of all universities (except Oxford and Cambridge) and university colleges in the United Kingdom; (2) principals, or directors, of all technical colleges represented in the Association of Technical Institutions; (3) secretaries of every university extension delegacy or board, of the Workers' Educational Association, the Gilchrist Trust and like organizations; (4) secretaries of all corresponding societies and of forty other local scientific societies; (5) curators of the chief provincial museums; (6) a few individuals having special knowledge of the subject.

By the middle of August, about 150 circulars had been returned, nearly all of them containing replies to the questions and also many valuable comments. The whole of these replies—about 1,500 in all—have been classified, and a digest of their substance is here given. The first question asked for the name of the society or institution providing the information.

ABSTRACT OF REPLIES TO QUESTIONS

2. *Are arrangements made for the delivery of public lectures upon scientific subjects each session? If so, (a) are the lectures free? (b) What are the lowest and highest charges for admission?*

In most cases local scientific societies arrange for the delivery of occasional popular lectures each session. These lectures, however, are not usually intended for the general public, but for members of the societies and any friends who may accompany them. The lectures are thus more of the nature of scientific meetings than public assemblies, and the fee for admission to them is the membership subscription, which varies from 1 s. to a guinea per session. In a few cases one or more public lectures are arranged each session, and admission to these is free, or at nominal charges varying from 1 d. to 6 d.

Series of public lectures are arranged by several corporations in connection with museums, libraries and other institutions, as well as by universities and technical colleges. The annual series of corporation free lectures at Liverpool includes scientific subjects; at the Horniman Museum, Forest Hill, S.E., twenty free lectures are given on Saturday afternoons from October to March; at the Manchester Museum, sixteen public lectures are arranged each year; at the National Museum of Wales, Cardiff, lectures are given from time to time in connection with special exhibits in the museum; at the Technical School, Barrow-in-Furness, a course of popular lectures is delivered on Saturday evenings; and at the museum, free library and Bentlif Art Gallery, Maidstone, free popular lectures were successfully arranged every winter before the war. The secretary of the Buchan Club, Aberdeen, remarks of public lectures:

> They were formerly given until they declined for want of suitable lecturers and variety of lectures.

And the principal of Battersea Polytechnic says:

> We have discontinued the arrangement of popular lectures as the attendance was discouraging. We have found that the people in this district will not attend popular lectures, whatever the subject. We have offered lectures by such men as Max O'Rell, E. T. Reed, T. Foster Fraser, T. P. O'Connor, Sir J. D. Maclure, F. Villiers, Fred Enoch and H. Furniss; and the response of the public was disappointing, although the charge for admission was only 3 d. We arranged for a lecture on "Air-ships" in the spring of this year, but failed to secure an audience and had to cancel the lecture.

3. *Where are the lectures usually given? (a) What is approximately the average attendance?*

Lectures given in rooms of museums,

public libraries, universities, technical schools and like institutions, attended by members of scientific societies and their friends, have usually audiences of about 30 in number, and the limit of accommodation does not often exceed about 200. The average attendance of the whole of the lectures, of which particulars have been received, is about 300. In the town hall, Stockport, the average is 1,250, "but this is a decreasing number;" at the Mechanics' Institution, Burnley, it is 800–1,200; at the town hall, Portsmouth, 500–2,000; at the Merchant Venturers' Technical College, Bristol, 600–800; at the Birmingham and Midland Institute, 700; at the Albert Institute, Dundee, 500–800; at various towns distributed through England, Wales and Ireland the average attendance at Gilchrist Lectures is about 600; and at the Geographical Institute, Newcastle, about 500.

4. *What subjects attract the largest audiences?*

From the point of view of local scientific societies, the most popular subjects are local archeology and antiquities, animal and bird life, and other aspects of natural history. The most popular public lectures are those on travel and adventure by explorers whose names are widely known. Astronomy is rarely mentioned, but this is probably because local scientific societies are mostly concerned with natural history and there are few good lecturers on astronomy. Science lectures must be illustrated by lantern slides or experiments if they are to appeal to a large public, and their titles should arrest attention. The chief point, however, is that lectures should deal with recent discoveries or topics which have been mentioned frequently in the daily newspapers. The largest audiences are usually attracted not by descriptive lectures on such subjects as mimicry, the descent of man, prehistoric animals, trade processes, and so on, but by those which are concerned with questions of wide economic or sociological interest, such as industrial research in America, wireless telegraphy in war, the wages problem, munitions of war, etc. One correspondent says:

> Purely scientific lectures do not attract, however eminent the lecturer. The most attractive lectures are the least scientific.

5. *Do you attach as much importance to the lecturer as to the subject?*

As much, or more, importance is usually attached to the lecturer as to the subject. Most of the replies are in this sense, and the following are typical of them: "The society does not, but the audience does;" "In order to attract subscribers, the chief importance is attached to the personality and celebrity of the lecturer;" "The lecturer practically determines the audience;" "Undoubtedly, if the lecturer is well known;" "Yes, more, for popular lectures;" "More to the lecturer, if known: if not known, to the subject." The best combination is, of course, an attractive subject and a celebrated lecturer, and the public soon forms its own estimate of the two factors. "The subject attracts in the first instance, but a poor lecturer would not draw a second time."

> Under the conditions here [Forest Hill, S.E., Horniman Museum], where there is a large population to draw on, title and subject are probably more important than lecturer. Nevertheless, some lecturers are always fairly sure of a good audience, and a series which begins with lectures by relatively poor lecturers soon suffers a reduction in size of audiences.

In many cases the lectures are given by members of the staffs of local museums, universities, or other institutions, but this limitation of choice of lecturer and subject soon exhausts the public interested in them.

6. *Are lectures by strangers generally more or less successful than those by local lecturers?*

When the visitor is a celebrated lecturer,

it is natural that larger audiences should be secured than in the case of local lecturers. Probably strangers are not invited to lecture unless they have more than a local reputation, and this accounts for the general opinion that they are more successful as regards size of audience. Typical replies to this question are: "Lectures by strangers, especially when they are celebrities, are far more attractive;" "Yes, as they are usually well-advertised; otherwise, I doubt if the numbers would be increased;" "Except for lecturers of world-wide fame, we find the attendance about the same for local lecturers as for outside lecturers;" "A known name, local or otherwise, is generally more attractive than that of a completely unknown person;" "Strangers distinguished in literature, science or public life generally attract good audiences. In the case of scientific lectures, local lecturers appeal more to the general public owing to the fact that it is a difficult matter for an outside lecturer to provide adequate experiments. The majority of these lectures in the past have been delivered by our own staff" (University College, Nottingham). "It depends on the lecturer; when a local lecturer lectures repeatedly in the same district he ceases to draw really large audiences" (Manchester).

The general conclusion seems to be that for lectures to local societies, with audiences numbering from about 30 to 100, local lecturers "draw" as much as visiting lecturers of the same standing, but the visitor has to depend more upon the subject and title to attract an audience. "The fact that a prophet is not without honor save in his own country somewhat discounts the popularity of local lecturers; but a distinguished local man will attract a larger audience than a much less distinguished stranger" (Manchester).

7. *If fees are paid to lecturers, what is the usual amount for (a) Lectures with or without lantern slides, (b) Lectures with experimental illustrations?*

Few local societies have sufficient funds to pay lecturers: the result is that most scientific lectures arranged by these societies are given free or for out-of-pocket expenses. Members of the staffs of colleges and other institutions also usually give public lectures locally without fees. The general fee to professional lecturers, with lantern slides or experimental illustrations, or both, varies from three to ten guineas. Dr. Wertheimer, principal of the Merchant Venturers' College, Bristol, says, in answer to the question: "Varies with the lecturer. We have found some dear at five guineas and others cheap at fifteen guineas." The Stockport Science Lectures Committee usually pays ten guineas for a lecture, but in exceptional cases, as for Sir Ernest Shackleton and Sir H. B. Tree, forty guineas have been paid.

8. *With admission free, or at a nominal charge, and excluding the cost of the hire of a room or hall, what is the usual profit or loss upon a popular science lecture? (a) If there is a loss, how is it met?*

9. *Are any local funds available for people's lectures?*

As lectures to members of local scientific societies and their friends are usually given free, expenses are low and are met by the general funds of the societies. The secretary of the Buteshire Natural History Society says:

> Some years we have had lectures for the public for which a charge was made—about 6 d. There was usually a profit, after paying everything, of a few shillings.

There is, however, rarely a profit upon a public lecture. The Buchan Club, Aberdeen, estimates the loss at £1 to £2 per lecture, and it is paid from the funds of the society. Even with the well-arranged Gilchrist Lectures delivered in various parts

of the country, the average loss is about £10 a lecture and is met by a grant from the Gilchrist Trustees. At Stockport

the hall has been hired, with charges for admission. The greatest profit in the early years was approximately £20. In recent years there has been a loss. A number of local gentlemen guaranteed a guinea each in case of loss. No call has been made upon them.

At University College, Nottingham, the loss per lecture is from £2 to £5, but no allowance is made for the services of the lecturer and his assistant, or for the use of apparatus. In such cases the loss is met out of college funds. Lectures are likewise given in many places as part of the educational work of museums and the cost is paid out of the incomes of the institutions. When the museum is a municipal institution, or lectures are arranged by a Free Public Library Committee, any loss comes out of the rates. Thus the secretary of the Albert Institute, Dundee, says:

As the lectures are all delivered within the premises of the Free Library Committee, any charge for admission is prohibited by the Public Libraries Acts. The Albert Institute Lectures have proved so popular that they are regarded as a branch of the work of the Free Library Committee. A sum of about £25 is usually taken in the estimates of that committee for expenses—lantern operator, making slides, arranging halls, etc. All my lectures are gratuitous.

Similarly, the chief librarian of the Liverpool Public Libraries remarks:

The public libraries are rate-supported, and lectures are part of the public library work. This library was established by special Act of Parliament, and not under Ewart's Library Act. Authority was included in our Act to pay for lectures. The vote by our council for lectures during the past few years has been about £1,100 per year.

In other cases the cost of popular lectures is paid by the legal education committee or out of the grant made to the institution by the board of education.

Very few localities have special funds available for the expenses of public lectures. The secretary of the Kilmarnock Glenfield Ramblers' Society says, however: "The Kilmarnock Philosophical Society has considerable funds for providing lectures, but has not done so for many years." At Dundee,

the late Lord Armitstead gave, about twenty-five years ago, a sum to establish "The Armitstead Lectures." No local lecturers are engaged. A nominal charge for admission is made. These were formerly well attended, but latterly the attendance has fallen off. The Albert Institute Lectures now tax the full accommodation of the Albert Hall. They are absolutely free to the public.

There is at Perth a local trust fund, called the Duncan Bequest, for lectures; and at Maidstone the popular lectures are provided out of the Bentlif Wing Trust Fund of the museum, free library, and Bentlif Art Gallery. The Midland Institute, Birmingham, has a small endowment of about £30 a year for science lectures; and the Royal Technical College, Glasgow, has an endowment fund for popular lectures on astronomy. The Gilchrist Educational Trust is referred to in detail later. One of the purposes of the Chadwick Trust (40 Queen Anne Chambers, Westminster, S.W.) is to provide for "the delivery by competent persons of lectures on Sanitary Science," and a number of successful lectures have been given in pursuance of it, particularly during the war. Among the subjects of these recent lectures are: Racial Hygiene and the Wastage of War; War and Disease; Food in War-time; Typhus in Serbia; Prevention of Disease and Frostbite in the Army. The Trust pays all expenses of fees, hall, lantern, advertising and printing, though halls and lanterns are often lent.

10. *Has public interest in popular science lectures increased or decreased in your district during the past ten or twenty years?*

The analysis of replies to this question is

inconclusive. About one third of the correspondents report that interest has increased, another third that it has decreased, and the remaining third that it has remained stationary or no decided change has been noticed. Museums mostly report an increase of interest, and technical institutions a decrease. No general conclusion can be derived from the replies from scientific societies, in which so much depends upon the energy of the secretary and the constitution of the committee. For example, the Birmingham and Midland Institute Scientific Society reports an increase, while the Birmingham Natural History and Philosophical Society records a decrease.

As regards public interest in science lectures Dr. M. E. Sadler remarks: "I should say that it has increased and might be greatly stimulated by further efforts." Other replies to this effect are: "I do not believe that public interest in popular science lectures has decreased, but it certainly has less opportunities of manifesting itself" (School of Technology, Manchester). "There has been a marked increase of interest within the past five years" (University College, Aberystwyth); "In that time the public interest in our lectures has increased considerably" (Kilmarnock); "The interest in the Manchester Geographical Society's weekly lectures has greatly increased during the past fifteen years."

The chief causes of decrease of interest in many districts are indicated in the following replies: "The public interest has doubtless decreased slightly during the past ten years. This is to some extent accounted for by the fact that during recent years scholars from the secondary and other schools in the city have continued their education at the college and other institutions, attending two and three evenings per week, and therefore do not attend single lectures as in former years. The opening of picture-houses has probably also affected the attendance at lectures" (University College, Nottingham). "Decreased. The lectures are no longer novel, there is increasing difficulty in obtaining new and good lecturers, and there are many counter-attractions, *e. g.* kinema, other lectures in the same town, etc." (Stockport Science Lectures Committee). "Decreased: representatives on public bodies either have not the time (through commercial claims), or the interest, to devote any attention to the matter" (Chelmsford). "I should say decreased with the quality of the lecture. Good lectures are rare and generally well attended" (Plymouth).

The whole matter is admirably summed up by Mr. D. B. Morris, Town Clerk, Stirling, as follows:

Comparing the position of matters now with that of thirty years ago, the popular lecture does not now occupy the place in public esteem which it did. For this there are various causes. With the better type of young persons, attendance at continuation classes, with their organized schemes of study, takes the place of attendance at popular lectures. To the non-studious the picture-house is the habitual place of resort. Many of the films there shown are such as would be exhibited at a popular science lecture.

As regards older people, some find that life has to be lived more strenuously nowadays, and rest or quiet recreation are sought in the evening rather than anything distinctly intellectual. The great popular interest which used to be taken in natural history arising out of the "evolution" controversy, and inspired also by the writings of Darwin, Wallace, Huxley, Lubbock, Kingsley and others, has passed entirely away. Such interest now centers in subjects like wireless telegraphy, aviation, and, at present, all matters connected with the war.

Serious students will always be found to attend courses where educational value is to be got, but popular lectures will not succeed unless illustrated by kinematograph, lantern, or experiments, or by all three. The element of entertainment must be present, which implies novelty. Arrangements might be made with local picture-houses to have a fortnightly or monthly scientific evening, which

would take the form of a popular lecture with illustrations. Tickets, containing a short syllabus of the series, could be sold at cheap prices, a local organization assuming financial responsibility.

11. *Can you suggest any course of action to follow in order to increase public interest in science in your district by means of popular lectures?*

The chief needs referred to are: (1) a supply of trained popular lecturers; (2) coordination of effort of educational institutions, university extension committees, municipal corporations, trades councils, and similar bodies; (3) adequate advertisement and interesting press notices; (4) lectures dealing more especially with subjects of present-day interest, or relating to the needs of the district; (5) endowment of popular science lecturers so as to enable lectures to be provided at a moderate cost; (6) the use of the kinematograph in science lectures.

Many correspondents seem to think that popular lectures are necessarily of the instructive kind and intended to induce people to take up courses of study at educational institutions. They have little faith in such a means of increasing the number of students, and rightly so. The purpose of public lectures may be, however, not so much to create desire to study as to enlighten the community upon the relation of science to individual and national life. The point of view is thus entirely different from that of the local educational institution or the local scientific society, both of which regard popular lectures as possible means of securing new students or members. The position is clearly stated by Principal Garnett, School of Technology, Manchester, in the following reply:

A more general realization by competent lecturers of the benefits which popular lectures may confer upon the community and a greater readiness on the part of universities and colleges to spend money on the provision and advertisement of such lectures. At the present time eminent men of science are, with few (if any) exceptions, rendering in other ways more valuable national service than they could render by the delivery of popular lectures. Moreover, the restricted financial resources of governing bodies are probably more usefully employed in the conduct of research and in providing the education required by men who are to occupy responsible positions in the various industries. The financial difficulty would disappear if an inspiring account of the broad outlines of natural science formed part of the curriculum of every elementary and secondary school. This "science for all" is to be carefully distinguished from the science training given to those who are to pursue further the study of science in some institution of higher education or are to use it in their daily work.

Mr. R. J. Moss (Royal Dublin Society) says:

Much more attention must be given to science in school education. It should be made interesting and taught as much as possible by demonstration and experiment. In this way the coming generation may be enabled to appreciate science and to take an interest in the progress of knowledge. A great deal of good might be done by the creation of traveling lectureships to be held for a limited time by men who show an aptitude for the work.

12. *What do you consider are the chief elements of success, or reasons for failure, of public lectures upon scientific subjects?*

Among the conditions of success mentioned in replies to this question are: (1) The reputation and personality of the lecturer, (2) effective advertisement and newspaper reports, (3) energy and efficiency of local secretaries and committees, (4) attractive titles, and choice of topical or popular subjects, (5) plenty of lantern slides, use of bioscope films, or good experimental illustrations. It is obvious that a lecturer should adapt himself to his audience, and should possess expository power, so as to deal with his subject in a clear and interesting manner, without degenerating into the style of a public entertainer.

Professor Herdman states the chief ele-

ment of success to be "a good lecturer who can be heard, has a definite story to tell, and can tell it in plain language." This is also the view of Principal Garnett, who says: "The chief elements of success seem to me to be that the lecturer should be vividly conscious of the closest relation that exists, or that can be established, between his subject and the daily lives of his audience; and that he should possess an expert knowledge of his subject, a power of lucid exposition, and a pleasant and forcible delivery."

The replies received show that these conditions are rare among lecturers; and failure is often ascribed to the absence of them. A subject and style appropriate to a lecture at the Royal Institution are unsuitable for a working-class audience such as that at the Royal Victoria Hall, though this is sometimes forgotten. The librarian and director of the Sunderland Public Libraries, Museum, and Art Gallery, remarks:

The expertness of the lecturer and his constant association with experts often causes him to be ignorant of the ignorance of his audience. On the other hand, he is occasionally patronizing. In failing to approach his subject from their point of view he is occasionally "over their heads," and, despite his specialization, frequently fails where "a man of the people," or a non-expert, will succeed with less knowledge, but better judgment. There should be the same difference between a "popular lecture" and a scientific discourse, as between an interesting primer and an advanced scientific treatise in literature. The successful "popular" lecturer is, I think, more rare than the advanced or scientific lecturer. Failure may possibly be attributed to the growth of light-entertainment halls, or maybe to a wider and more popular treatment of subjects in the press. There is also a greater literature now, and a wider circulation of it through libraries.

Even in lectures to local scientific societies the subjects are frequently treated in too advanced a manner, and are therefore unintelligible to many of the audience. It is suggested by some correspondents that if more attention were given to science in schools there would be a larger attendance at popular lectures; but much depends upon the nature of the science teaching. The principal of the technical school, Barrow-in-Furness, writes:

I am afraid that one of the causes lies in the dreary nature of the instruction in "science" given in the day-schools (secondary). No one here who has learned chemistry, for instance, in a day-school seems to wish to learn more.

The thirst for amusement and excitement, no doubt, accounts largely for want of interest in science by the great majority of the public. There are now so many counter-attractions, such as picture palaces, music-halls, and other places of entertainment, that the general public is attracted to them rather than to lectures which require mental effort to understand them.

People want recreation after the day's work, and prefer amusement rather than instruction.

Experience shows that in an ordinary provincial town there is usually a small minority of intelligent persons who profit considerably from popular or semi-popular science lectures, but that the general community of the district is untouched by them.

Such attempts as have been made to reach larger audiences, with a low standard of education, by means of ultrapopular lectures have proved failures (Gloucester).

In this, as in most cases, lectures of the instructive type are referred to, and not those which aim at the appreciation of science as a living force in social economics or state affairs. Mr. H. J. Lowe, secretary of the Torquay Natural History Society, remarks:

The only way I can see to helping science into its proper position as an essential in national development is by the recognition and proclamation by the government and educational authorities of its immeasurable importance in attaining national efficiency. This should be followed by some general scientific knowledge being required in all pass-

ing examinations, as a guarantee of an acquaintance with science method and reasoning.

The provision now made for the study of scientific and technical subjects accounts, no doubt, for the failure of popular lectures in many districts. When there were few institutions of higher education, the thoughtful section of the population took advantage of such lectures to extend their knowledge, but now the same class is provided for in educational institutions and courses. The public science lectures of the present times, therefore, need not be of the same kind, or on the same subjects, as those of a past generation, but should be adapted to more modern needs and interests. Above all, they should be intended for the people as a whole, and not for students or others who propose to devote systematic attention to the subjects of the lectures or devote their careers to them. This distinction is not recognized in the subjoined remarks by Mr. C. F. Procter (Hon. Sec., Hull Scientific and Field Naturalists' Club), which represent the views of many scientific societies as to the present position, yet it is most important.

Mr. Procter says:

Scientific lectures can only be made popular in the sense that you attract the crowd of unscientific people, with a profusion of experiments, or, failing that, lantern illustrations. People will flock to the Egyptian Hall and are vastly entertained and educated a little by an exhibition of what is often clever scientific acrobatics. Human nature loves to see what it can not understand, and twenty years ago represents a period when the commonplaces of science were a wonderland to the average mind. The trend of education has altered that, and has sharply divided the same people into a minority of scientific enthusiasts who "ask for more," and a majority of indifferents who remain cold at a display of the old elementary stuff. Education (and that includes very largely the popular science lectures of the past) has created in this, as in all the arts, a small aristocracy of intellect, or, rather, comparatively small. These are not satisfied with anything that can possibly be popular. They are long past that, but will feverishly attend anything which proposes further to explore the deep water. The crowd—the man in the street and his womenkind—has had its wonder-bump excised in the school laboratory. Modern sensationalism in amusement and the plethora of scrappy yet crisp literature (which religiously exploits every new thing, scientific or otherwise, that may entertain) has calloused this excision. The application of the film-pictures to microscopy, etc., is about the only way to popularize science lectures, but—why bother? We can not all be men of science, and the present system provides that any who get the call may answer it, whilst popular lectures only attempt to entertain individuals of an age who are already past the slightest hope of ever being useful scientists. The proper thing is already being done by our schools, universities and university extension lecturers with our budding professors.

The following letter from the acting registrar of University College, Nottingham, bears upon some of the foregoing points:

Popular lectures have been delivered for the past thirty-five years at this college. During the past few years the numbers delivered on science subjects have been less than in previous years, but there is good reason to believe that if some pecuniary assistance from a central fund could be devoted to lectures on science much progress might be made, not only in this city but throughout the whole of the East Midland area. At one time it was the practise to arrange during each session two or three series of lectures on scientific subjects during the winter terms. These series consisted of three or four weekly lectures on each subject and were generally delivered by professors of the college. The professors received no extra remuneration for this work and as the ordinary college work grew it was almost impossible for the time to be spent in the preparation, which, it can be well understood, was very extensive. Ten to fifteen years back we always had crowded audiences, but these were cut down owing to the opening of so many picture-houses in the city and also to the fact that many of the senior scholars from the secondary and other schools now continue their education at the college and other institutions, attending two and three evenings per week.

CONSTRUCTIVE PROPOSALS

Many correspondents are of the opinion that the formation of a panel of lecturers

who would be prepared to assist small societies by lecturing for a small fee would be of great assistance. Mr. H. V. Thompson, Hon. Sec. of the North Staffordshire Field Club, says:

It would greatly facilitate matters if the British Association prepared a list of lecturers on various scientific subjects who, although not necessarily in the first rank of scientific attainment, could be relied upon to give lectures which would hold and interest a normal popular audience. This course would much assist local clubs and societies in the difficult choice of lecturers and also enable them to gauge the interest in science in the district. Furthermore, promising young men would be introduced to districts where they are unknown at the present time.

Mr. H. E. Forrest, Hon. Sec. of the Caradoc and Severn Valley Field Club, makes much the same suggestion, as follows:

I think local societies might help each other a great deal more than they do. In almost every society there are one or two members who are good lecturers on some particular branch of natural science. These might, in many instances, be willing to lecture to other societies for their expenses or a nominal fee. I suggest that you prepare a list of these gentlemen (giving addresses), with the subjects on which they lecture, and send the list to all corresponding societies, leaving it to their secretaries to make arrangements direct with the respective lecturers.

Mr. Herbert Bolton, curator of the Bristol Museum and Art Gallery, suggests that there should be an exchange system of lecturers among museum curators:

If, say, a dozen curators had all to work up lectures upon subjects with which they are familiar, they could, by arrangement, deliver the lectures at eleven other places in addition to their own, and so put in a good winter's work and make a good lecture reach a wide audience.

Similar suggestions are made by several correspondents for the exchange of lecturers among local scientific societies.

SUMMARY

1. Many local societies arrange for the delivery of occasional popular or semi-popular science lectures, but the audiences are mostly made up of members and their friends.

2. In most places there is a small circle of people interested in scientific work and development, and sufficient means exist to enable them to extend their acquaintance with diverse branches of natural knowledge, but the great bulk of the community is outside this circle and is untouched by its influence.

3. Popular lectures on scientific subjects do not usually attract such large audiences as formerly in most parts of the kingdom. To make a wide appeal to the general public the same principles of organization, advertisement and selection of lecturer and subject must be followed, as are adopted by agents of other public performances.

4. Increase in the number of educational institutions has provided for the needs of most persons who wish to study science, either to gain knowledge or prepare for a career. Other people seek entertainment rather than mental effort in their leisure hours, and they require subjects of topical interest, or of social and political importance, to attract them to lectures.

5. Few popular lectures pay their expenses, and scarcely a single local society has a special fund upon which it can draw in order to meet the cost involved in the provision of a first-rate lecturer and adequate advertisement.

6. Expenses of public lectures are usually paid from (*a*) general funds of local societies; (*b*) college or museum funds; (*c*) rates; (*d*) education grants; or (*e*) Gilchrist and other trusts.

7. After the war there will be a new public for lectures and courses on a wide range of subjects; but one of the main purposes of the lectures should be to show as many people as possible that they are personally concerned as citizens with the posi-

tion of science in the state, in industry and in education.

RECOMMENDATIONS

1. That an annual list of public lecturers on science subjects be prepared and published, with titles of their lectures. No fees should be mentioned in the list, but addresses should be given so that committees organizing lectures may make their own arrangements with lecturers. Local scientific societies, museums and institutions of higher education should be invited to send the names of members of their bodies prepared to deliver lectures to similar bodies elsewhere without fee other than traveling expenses, and the names of such voluntary lecturers should be indicated in the list by a distinguishing mark.

2. That committees organizing public science lectures should include representatives of as many interests as possible, such as municipal corporations, trades councils, cooperative societies, religious bodies, university extension committees, chambers of commerce, educational institutions, local scientific societies and like organizations concerned with the daily work and intellectual life of the district.

3. That to extend interest in science, and belief in its influence, beyond the narrow circle of serious students, increased use of the bioscope in illustrating natural objects, scenes and phenomena is desirable; and an appeal should be made to the interests of all classes of the community by addresses intended to show the relation of science and scientific method to national life and modern development.

4. That to carry on the propaganda of efficiency through science, local committees should endeavor to secure financial support from manufacturers and others affected by national progress, and that local educational authorities be asked to provide funds to enable free popular lectures of a descriptive kind, for children as well as for adults, to be well-advertised and for reasonable fees to be paid for lecturers and their illustrations.

5. That more encouragement should be given at university institutions and training colleges to the art of exposition and public speaking, for the benefit of those students and teachers whose aptitudes may later be usefully exercised in promoting interest in science.

6. That while the training of an adequate number of scientific workers is of prime importance, it is desirable that everyone should be made acquainted with the broad outlines of natural science while at school, and that public appreciation of scientific knowledge as an essential factor of modern progress should afterwards be created and fostered by means of popular lectures.

7. That this report be brought under the notice of each section of the association with the object of obtaining suggestions upon which organized action may be taken in connection with the Gilchrist Trust or independently.

8. That the committee be reappointed as a committee of Section L, its constitution remaining, as at present, representative of all the sections of the association, but with power to add to its numbers.

THE FOURTEENTH NEW ENGLAND INTERCOLLEGIATE GEOLOGICAL EXCURSION

The annual meeting of the geologists of the New England colleges and universities was held on Friday and Saturday, October 27–28, under the direction of Professors W. O. Crosby and C. H. Warren, of the Massachusetts Institute of Technology.

The purpose of the excursion was to study the batholithic cycle of the Blue Hills at Quincy, Massachusetts. Here the intricate

relations are well displayed, are not obscured by later dynamo-metamorphism, and have been determined with notable thoroughness and skill in independent and supplemental work by Crosby, Loughlin and Warren; Professor Crosby's results having been published in 1895, Loughlin's in 1911, and Warren's in 1913.

Preliminary explanations of the geology were given with the aid of lantern slides by Professors Crosby and Warren Friday evening, October 27, in the lecture room of the Boston Society of Natural History. The excursion, participated in by 39 persons, representing 12 institutions, left Boston at 8:49 A.M., October 28, and returned at 5:30 P.M. Superb weather, the beauty of the Blue Hills in autumnal foliage, the geological interest of the rock exposures, and the instructive interpretation of them by the leaders, combined to make memorable this excursion.

A synopsis of the geological relations of the Blue Hills complex as they were shown in the course of the day is as follows:

The invaded sediments are dark, uniform, siliceous argillites of Cambrian age. They were closely folded and were metamorphosed by the contact action of the underlying magma into hornstones. The structural relations show that they are remnants of a cover which before erosion extended over a considerable portion of the Quincy granite batholith. Some parts, now marginal, are preserved because they have been down-folded and down-faulted below the present level of erosion. Some isolated remnants indicate by their parallel orientation within the abyssal rocks that they were roof pendants, other outcrops show by their lack of orientation that they were marginal inclusions of greater or less size. These hornstones preserve within them diabase dikes, showing thus the nature of the advance intrusions from the magma which gave rise to the Quincy intrusions. The initial age of these dikes was clearly shown by their restriction to the sedimentary cover and one was pointed out which, furthermore, was cut by a thin dike of fine-grained granite. Next in the series to the diabase dikes is the conspicuous rhomben porphyry, the matrix of which is as dark as the diabase, but whose composition is in reality intermediate between that of the diabase and that of the granite. The series thus indicates a progressive differentiation, but discontinuous intrusion. The rhomben porphyry is associated with the margins of the sedimentary cover and is found also abundantly as angular blocks, cognate xenoliths, within the next marginal phase. During the process of crystallization of the rhomben porphyry there was repeated shattering and invasion by slightly different phases of the same magma. Finally the zone was shattered and invaded by a distinctly differentiated magma, the third of the series. This crystallized as a granite porphyry. It occurs in places in considerable mass, but elsewhere may exist as discontinuous fine-grained rims one or two inches thick about the xenolithic blocks of older phases. In places where a cracking but not disruption of the rhomben porphyry occurred there was some thin infiltration of the following magma accompanied by a metasomatic impregnation of the walls to a depth of a quarter to half inch, bringing about by recrystallization an approach to the nature of the later rock. One of the most interesting relations of the granite porphyry was seen in its chilled contacts with an aporhyolite. The latter appears to have formed a thin chilled cover to the batholith, made from the same magma, yet cut by the porphyritic phase. It indicates that the roof of older rocks had here been destroyed after the stage of the rhomben porphyry and that the batholith was in effect partly deroofed in this acidic stage. Following the granite porphyry came, after another interval permitting some slight further differentiation, the great upwelling of the Quincy granite. This, the main rock of the batholith, was followed later by the feeble injection of a few diabase dikes, closing the cycle. In the opinion of Professor Warren the structure of the roof of the batholith indicates invasion chiefly by stoping.

This small batholith is regarded as a local and structurally high intrusion belonging to the far wider and more complex batholith, which underlies much of New England, which

outcrops in many areas where erosion has worn through the ancient cover, and whose intrusive history covers a long period of time in the upper Paleozoic.

The age relations of the Quincy succession are limited by the facts that the igneous rock cuts the Cambrian sediments and is covered by Carboniferous conglomerates which rest upon the eroded surface of the porphyry. The age is regarded by the leaders as probably Devonian or Mississippian.

In the unavoidable absence of the permanent secretary, Professor Cleland, this record of the excursion is made at his request by the secretary *pro tem.*

JOSEPH BARRELL

YALE UNIVERSITY

CLEVELAND ABBE

IT fell to the lot of this modest man, a distinguished representative of American science, to initiate the national systems of weather forecasting which are to-day maintained by nearly every civilized nation of importance. With the science of meteorology Abbe's name will be associated through the coming ages.

With the death of Cleveland Abbe, chief meteorologist of the United States Weather Bureau, terminated the original phase of national meteorological work in America, for he was the sole surviving active official of the bureau in which he had served forty-six years.

As one of his associates, I accepted the invitation of SCIENCE to pay a tribute to his memory, which adheres to personal relations, and not to the evolution of that great idea which took possession of his soul in the small astronomical observatory in Cincinnati, an idea which was to blossom forth in practical form throughout the world.

When in 1870, at the invitation of Chief Signal Officer A. J. Myer, Abbe entered the signal office of the army to undertake the work of predicting the weather of the United States, he found his position and his duties most onerous and embarrassing. The environment was military, and the young officers had been drafted into scientific work that was tentative and unknown. Besides initiating a novel service Abbe was to cooperate with civilian scientists and to train in the new work officers fresh from the western frontier, from the military academy and from remote artillery seacoast stations. He entered on these manifold duties with the same equanimity and devotion as had marked his astronomical work in Russia and at home. The original scientific force engaged in weather and flood forecasts were nine in number. Besides the civilians, Abbe, T. B. Maury and William Ferrel, there were Chief Signal Officer A. J. Myer, Lieutenants R. Craig, H. H. C. Dunwoody, A. W. Greely, C. E. Kilbourne and J. P. Story. All are dead except Craig, Dunwoody and Greely, who are on the retired list of the army.

Through all the changes, from military to civic control, from one weather bureau chief to another, Abbe continued steadily at his scientific work under six separate administrative chiefs, active along lines of study and research to the last. It is interesting to note that the scientific bodies of the country have not contributed more than half a dozen officials of prominence to the bureau—though it has been under civil control 26 years—to the present force which has grown up under lines initiated by the practicality of Myer and the theories of Abbe.

During twenty years of his service I was intimately associated with Abbe as his subordinate and pupil, as a coworker, and as his administrative chief. During this term of years there inevitably developed situations which were complex, annoying and embarrassing to the scientific force. Yet in all such conditions I never knew him to display bad temper, to unduly prolong discussions, to advance personal interests, nor to abate his most strenuous efforts to carry out such policies as were judged needful for the good of the service—even though they had not originally met with his approval.

As a student in various subjects, such as light, heat, meteorology, etc., as a lieutenant I taxed for months his amiability and temper, for his very serious and methodical methods often excited my amusement and led to jocose

and sarcastic comments, which he always met with gentleness and sorrow.

His weather forecasts, from which he gained deserved fame, were always deduced by strictly considering the effects that should follow certain observed conditions. An amusing instance of that practise gained wide circulation among the office force. At 10 A.M. it suddenly began to rain in Washington, and at 10:15 A.M. Abbe predicted that there would be no rain in the city for the 24 hours beginning at 8 A.M. that day. When taxed with it he simply said: "There was nothing in the conditions shown by the map that scientifically indicated rain." He was equally true to his beliefs in all other directions. Fidelity and loyalty marked his long public career, and in Browning's words Cleveland Abbe could truthfully say that of his life, he "learned to love the true."

A. W. GREELY

THE AMERICAN SOCIETY OF NATURALISTS

THE American Society of Naturalists, in affiliation with the American Association of Anatomists, the American Society of Zoologists, and the Botanical Society of America, will hold its thirty-fourth annual meeting at New York, under the auspices of Columbia University, on Friday, December 29, 1916, and, by invitation of the Carnegie Station for Experimental Evolution, at Cold Spring Harbor on Saturday, December 30.

The Botanical Society of America will place the genetical papers of its program on Thursday morning December 28, and the American Society of Zoologists will group its genetical papers in a program for Thursday afternoon. By this arrangement there will be sessions of genetical interest on the day preceding the meetings of the Naturalists and continuing with the Naturalists' programs for Friday and Saturday.

The Friday morning session of the Naturalists will be open for papers on evolution, genetics, and related subjects from members or invited guests, titles of which with estimated length of delivery must be in the hands of the secretary by December 1. Requests for microscopes or for space for demonstrations should also be sent to the secretary.

The program of Friday afternoon will be a symposium on "Biology and National Existence," with papers by Stewart Paton, W. J. Spillman, V. L. Kellogg, Jacques Loeb and E. G. Conklin.

The annual dinner, in which members of the affiliated societies are invited to participate, will be held in the evening of Friday at the Hotel Manhattan, which has been selected as the headquarters of the Naturalists.

There will be a joint smoker for members of the Naturalists and of the affiliated societies at the Columbia University Commons, Wednesday evening, December 27.

Members of the American Society of Naturalists are invited by the Carnegie Station for Experimental Evolution to spend Saturday, December 30, at Cold Spring Harbor. A morning session from 10.30 to 1 will be held in Blackford Hall for the presentation of genetical papers. After a lunch there will be opportunity to inspect the equipment of the station, the activities of which will be explained by the staff. Arrangements for trains will be announced in the final program.

BRADLEY M. DAVIS,
Secretary

THE ENDOWMENT OF THE MEDICAL DEPARTMENT OF THE UNIVERSITY OF CHICAGO

THE General Education Board and the Rockefeller Foundation have appropriated \$2,000,000 (each \$1,000,000) for the establishment of a medical department in the University of Chicago. It brings Mr. Rockefeller's contributions to the university up to nearly \$37,000,000.

The university will set aside at least \$2,000,000 for the same purpose, will give a site on the Midway valued at \$500,000, and will raise a further sum of \$3,300,000. The medical school will therefore start with an endowment of almost \$8,000,000.

Rush Medical College, established seventy-five years ago, will go out of existence. The Presbyterian Hospital which Rush College

has used, will be taken over by the University of Chicago and will be reorganized to provide adequate clinical and laboratory facilities. A new laboratory building will be erected in immediate conjunction with the hospital. The buildings and grounds of the Presbyterian Hospital are valued at about $3,000,000.

A statement given out by Dr. Abraham Flexner says:

This project will be giving the city of Chicago a high-grade medical school and it will also provide for the first time in this country a post-graduate school adequately equipped and financed.

The school will be erected on the Midway Plaisance, and will thus form a part of the present University of Chicago plant. High-grade modern laboratory buildings will be provided for instruction in the students' first and second years, and a university hospital under complete control of the university, with laboratories and an out patient department, will be built on the Midway.

The entire teaching staff, clinical as well as laboratory, will be organized on the full time basis. That is, all the teachers for clinical as well as laboratory studies will give their entire time to teaching and research in the university hospital and medical school. Professors and their assistants will hold their posts on condition that they become salaried university officials and that they accept personally no fees whatever for any medical or surgical services.

The only medical schools in the country to-day which have embraced the full time teaching plan are Johns Hopkins Medical School and the medical department of Washington University, St. Louis.

The full-time scheme is a plan to insure to hospital work and medical teaching the undivided energy of eminent scientists whose efforts might otherwise be distracted by the conflicting demands of private practise and clinical teaching. The full time scheme is an appeal to scientific interests and devotion of the clinician, and the results so far realized through the plan at Johns Hopkins have been most satisfactory.

It should be of increasing consequence to the public that the training of those studying to become doctors should be in charge of the most competent men obtainable devoting their entire time to this work. Greatly increased efficiency and thoroughness should result, to the alleviation of suffering and the cure of disease.

The new institution thus to be established in Chicago will be equipped with every modern facility for medical instruction and with ample funds for operation.

SCIENTIFIC NOTES AND NEWS

THE American Academy of Arts and Sciences on November 15 presented the Rumford medals to Mr. Charles Greeley Abbot, of the Smithsonian Institution, for his researches on solar radiation.

DR. GEORGE F. KAY, head of the department of geology of the University of Iowa and state geologist of Iowa, has been elected university research lecturer for the current year. During each year the university lecturer visits the educational institutions of Iowa and delivers a lecture in which is involved the spirit of research. This policy has been followed successfully for about ten years.

DR. JOSEPH J. KINYOUN, bacteriologist of the health department of the District of Columbia, who, at the request of the authorities of Winston-Salem, N. C., has been for several months engaged in the reorganization of the health department of that city, has resumed his duties in Washington.

MAJOR-GENERAL GOETHALS, governor of the Panama Canal Zone, will pass into the retired list of the army on his own application dating from November 15, after forty years' service. The order of retirement affects only General Goethals's military status and does not operate to relieve him from duty as governor of the Canal Zone, but is preliminary to his retirement.

THE Sociedad Argentina de Ciencias Naturales, Buenos Aires, has elected as corresponding members Sir Ernest Shackleton and Mr. W. H. Hudson, the author of "Argentine Ornithology" and other works.

ON the occasion of his seventieth birthday on December 7, 1915, Professor A. Voss, of the University of Munich, received from the Munich technical high school the honorary degree of doctor of technical sciences.

AT the annual meeting of the British Astronomical Association on October 25, it was

stated that Major F. L. Grant, who had been severely wounded at the front, had resigned the secretaryship. Mr. W. Heath, M.A., was appointed to the vacancy.

Dr. J. L. E. Dreyer has resigned his office as director of the Armagh Observatory, a position which he has held since 1882.

In addition to the awards announced in April for papers read at the meetings, the council of the British Institution of Civil Engineers have made the following awards for papers published in the *Proceedings* without discussion during the session 1915–16: Telford Premiums to Messrs. Hubert Mawson (Liverpool), T. W. Keele (Sydney), R. W. Holmes (Wellington, N. Z.), W. Fairley (London), J. M. Greathead (Johannesburg), T. C. Hood (Manmad, India), and J. B. Ball (London); the Manby Premium to Mr. W. C. Cushing (Pittsburgh, U. S. A.), and the Crampton Prize to Major C. E. P. Sankey, D.S.O., R.E. (London). The Indian Premium for 1916 has been awarded to Sir John Benton, K.C.I.E. (Eastbourne).

Professor C. R. Orton, of Pennsylvania State College, is on leave of absence for one year and has registered for graduate work at Columbia University. He will spend some time at the New York Botanical Garden in connection with his researches on parasitic fungi.

The steam yacht *Alberta,* which is to carry a party of scientific men headed by Dr. Alexander Hamilton Rice up the Amazon River, left New York City, November 15, for South America. The expedition plans to make a topographical survey of portions of the Amazon valley and interior districts and studies of the diseases of natives in that section. The members of the party include, besides Dr. and Mrs. Rice, Dr. William T. Councilman, pathologist of Harvard University; Earl S. Church, of Newport, of the United States Coast and Geodetic Survey, and Ernest Howe, of Newport, geologist.

At the recent meeting of the Clinical Congress of Surgeons held in the various institutions in Philadelphia, Dr. John C. Clark, chief operating surgeon at the University Hospital and professor of gynecology at the University of Pennsylvania, was elected president. The next meeting of the congress will be held in New York City.

Dean Francis C. Shenehon, of the College of Engineering of the University of Minnesota, has been engaged as consulting engineer since the middle of June on hydraulic investigations in Illinois and will be absent from the university almost continuously until the middle of December.

Dr. Robert M. Lewis has left for Shanghai, China, where he will be associated with Dr. McCracken, teaching in the University of Pennsylvania Medical School of China, which a few years ago became a department of St. John's University. He goes as one of the representatives of the Christian Association of the University of Pennsylvania and expects to return some time in the spring. He has lately been associated with his uncle, Dr. Howard A. Kelly, in surgical work at the Johns Hopkins University.

Mr. Edwin T. Hodge, who has been pursuing graduate studies in geology at Columbia University for the past two years, and has spent one summer season in field investigation in Porto Rico, has been given a position on the instruction staff in the department of geology in the University of British Columbia.

The Harveian oration before the Royal College of Physicians of London was delivered by Sir Thomas Barlow on October 18.

The address of the retiring president at the anniversary meeting of the London Mathematical Society, on November 2, was delivered by Sir Joseph Larmor, who took as his subject "The Fourier Harmonic Analysis: its Practical Scope and its Limitations."

The Bradshaw lecture before the Royal College of Physicians of London was delivered on November 2 by Dr. Hector Mackenzie, whose subject was exophthalmic goitre. The Horace Dobell lecture was delivered on November 7 by Dr. H. R. Dean, on the mechanism of the serum reactions. Dr. W. H. R. Rivers has given a second course of FitzPatrick lectures

on medicine, magic and religion, on November 14 and 16.

ANOTHER course of Chadwick public lectures has been arranged. Professor Stirling gave the first of three lectures on fatigue and its effects on industry and efficiency, at the Royal Society of Arts, Adelphi, on October 27. Dr. Charles Porter began a course of three lectures on the health of the future citizen, at the Norwich Museum on November 2; Dr. J. C. Nash, county medical officer and chief school officer, Norfolk, will give a lecture on baby saving for the nation, at the Hampstead Central Library on November 20; and Mr. Paul Waterhouse will give the first of three lectures on architecture in relation to health and welfare, at the Surveyors' Institute, Westminster, on November 30.

THE birthplace of Weierstrass in Osterfelde in Westphalia has recently been marked by a memorial tablet.

THE death is announced of Arthur G. Smith, head of the department of mathematics and astronomy in the University of Iowa.

A. B. ALEXANDER, assistant in charge of the Bureau of Statistics of the United States Fisheries Commission at Washington, has died.

DR. JULIUS H. EICHBERG, professor of materia medica in the college of medicine, University of Cincinnati, died on October 31, 1916.

THE death is announced of Dr. Jean-Joseph Picot, formerly professor of clinical medicine at the Bordeaux School of Medicine, at the age of seventy-seven years, and of G. Salomon, professor of physiological chemistry at the University of Berlin, aged sixty-seven years.

MAURYCY RUDZKI, since 1902 director of the Cracow Observatory, has died at the age of fifty-four years.

AT the invitation of Dr. E. C. Pickering, the fourth annual meeting of the American Association of Variable Star Observers will be held at the Harvard College Observatory, on November 18, 1916.

IT is announced from Sweden, that no Nobel prizes for science or medicine will be awarded for this year, but that the money will be reserved for 1917. The money for the prizes for 1915 has also been reserved and will be added to the special fund.

WE learn from *Nature* that Professor A. S. Donner, director of the observatory at Helsingfors, has presented to the university, of which he was formerly rector, the sum of £8,000, to ensure the continuance, and indeed the completion, of the "Catalogue photographique du Ciel, Zone de Helsingfors," begun under his direction in 1890. Hitherto the work has been paid for, partly by the university, partly by Professor Donner out of his private means. The sum now allotted by him is intended to cover all expenses for twelve years, when, at its present rate of progress, the task should be finished.

UNIVERSITY AND EDUCATIONAL NEWS

AMHERST COLLEGE has received a gift of $100,000 from Mrs. Rufus Pratt Lincoln, of Plainfield, N. J., to establish a chair of science. Professor John M. Tyler, professor of biology in the college since 1879, has been elected the first Rufus Tyler Lincoln professor. Amherst College has also received a bequest of $5,000, to be known as the Edward Tuckerman Fund, for work in botany.

PROFESSOR WILLIAM ESSON, late Savillian professor of geometry at Oxford, by his will gives ultimately to Merton College and the University of Oxford his estate, the value of which is about $55,000.

DR. JOHN SHARSHALL GRASTY, formerly associate professor of geology at the University of Virginia, has resigned to take charge of the new department of mining geology recently established at Washington and Lee University. Dr. Albert William Giles has been appointed adjunct professor of geology in the University of Virginia.

THE *Bulletin* of the American Mathematical Society announces appointments of instructors in mathematics as follows: C. H. Clevenger in the school of mines of the University of Minnesota; C. N. Reynolds in Wesleyan University; P. R. Rider in Washington University;

J. J. Tanzola, of Columbia University, in the U. S. Naval Academy, and Dr. C. H. Forsyth, of the University of Michigan, in Dartmouth College.

Dr. Chas. H. Otis has resigned his position as instructor in botany and assistant botanist at New Hampshire College and Experiment Station, to accept a position in the biological laboratory at Western Reserve University. Dr. Otis will have charge of the instruction in botany in Adelbert College and the College for Women, taking the place of Dr. Wm. H. Weston, who recently resigned.

Mr. Paul C. Graff has been appointed instructor in botany at the University of Montana.

DISCUSSION AND CORRESPONDENCE

FURTHER EVIDENCE BEARING ON THE AGE OF THE RED BEDS IN THE RIO GRANDE VALLEY, NEW MEXICO

The almost total lack of invertebrate fossils in the Red Beds exposed on the eastern side of the Rio Grande Valley has made it very difficult to determine their exact position in the geologic column. In some localities definite determinations have been made, largely upon stratigraphic evidence, showing that the red sandstones and shales occur at horizons ranging from the Upper Pennsylvanian to the Cretaceous. The work upon this region has been reviewed by Lee and Girty.[1]

During the last summer, while engaged in a survey of the Permo-Carboniferous boundary line for the Carnegie Institution, the writer was able to spend a short time in the Red Beds near Socorro, New Mexico. The examination was made possible by suggestions and maps furnished through the kindness of Dr. N. H. Darton, of the U. S. Geological Survey.

Two or three miles north of Carthage, New Mexico, the prominent ridge of Dakota sandstone is underlain by a series of shales and sandstone varying in color from bright green to brilliant red with a few patches of conglomerate and impure limestone of limited horizontal extent. The arid valley between the ridge and the hills to the north capped by the San Andreas limestone affords an excellent exposure of the beds.

[1] Lee, W. T., and Girty, Geo. H., "The Manzano Group of the Rio Grande Valley, New Mexico," Bulletin 389, U. S. Geological Survey, 1909.

Lee and Girty reported a few doubtful invertebrate fossils from the San Andreas at this place and speak of 200 feet of red beds overlying the limestone at the old lime kiln near Carthage.

No fossils were found in these upper beds and their age is a matter of conjecture.

They also report the Abo and Yeso formations as present, but the exact locality of their section is not given. The red beds above the San Andreas limestone are faulted down against it just at the old lime kiln and can be traced up the valley for several miles. Close to the lime kiln and about half way up to the base of the Cretaceous the writer found a small bed of conglomerate containing an abundance of lamellibranchs in a very small patch. These have not yet been identified.

A few fragments of bone were found in the same bed and further up the valley, but at a lower level, other fragments were found. The following list shows them, and the containing beds, to be clearly Triassic.

1. A small section, about four inches, of the snout of a slender-jawed Phytosaur, suggesting *Angistorhinus* or *Mystriosuchus*, with teeth diverging at an angle of 15 to 20°. This was found in a concretion in a dark brown, impure limestone occurring as a lens in the red shale.

2. Three vertebræ, found at different localities, apparently Phytosaurian.

3. The proximal and distal ends of a large limb bone, badly worn and unidentified, but certainly not related to any of the known forms of Permo-Carboniferous vertebrates.

4. Two small dorsal plates. One with a median dorsal ridge and the other, regularly hexagonal and with a ventral rugosity evidently for attachment to the dorsal spine of a vertebra.

5. Several imperfect ends of large limb bones; two suggesting the ends of a tibia and a radius respectively.

6. Two fragments of thoracic plates. One

from a large plate with deep radial flutings and the other, smaller, with similar markings. Both are evidently Stegocephalian.

7. A large vertebral centrum, evidently from a sterospondylus Stegocephalian.

Most of the bones were found in the conglomerate beds, but a few in lenses of impure limestone.

Lee and Girty also give a description of the beds near the Mesa del Yeso on the eastern side of the Valle del Ojo de la Parida and report typical Manzano fossils from the Yeso formation.

The Red Beds were examined by the writer near the Ojo de la Parida about ten miles northeast of Socorro, where the Abo, Yeso and San Andreas formations are easily recognized. In the Yeso and the upper part of the Abo no vertebrate fossils were found, but in the lower part of the beds near the mouth of the Canyoncito Colorado (see the Socorro topographic sheet) beds of dark red pebble conglomerate were found lying upon green, blue and drab shales which show in the bed of the arroyo. In this conglomerate were found typical Permo-Carboniferous bones such as were collected by Dr. Williston and the writer in Rio Arribo County, New Mexico. The following list shows the similarity:

1. A complete femur of *Eryops* sp.

2. The distal end of a clavicle of *Eryops* sp.

3. The distal end of a neural spine of *Eryops* sp.

4. A femur of *Sphenacodon*.

5. A fragment of the jaw with four teeth of *Sphenacodon*.

6. The distal end of the scapula of a *Sphenacodon* or *Ophiacodon*.

7. The distal end of a large scapula, possibly *Sphenacodon*.

8. Fragments of a large pelvis, possibly *Sphenacodon*.

9. In the bluish shale in the bank of arroyo, the proximal end of a rib of diadectid type associated with poorly preserved plant remains.

10. In the drab shale below the blue, several invertebrates.

The discovery of this fauna below the San Andreas limestone adds one more bit of evidence to those already cited by the author elsewhere, for the very early appearance of specialized reptilian life in North America.

E. C. Case

THE SWEET POTATO "SOIL ROT" OR "POX" ORGANISM[1]

Since Halstead in 1891 published his results on the study of "Soil Rot" of sweet potatoes, which he credited to a fungus "*Acrocystis batatas*," little positive work seems to have been done on the causative organism. During the present season observations by the author of slimy masses on the surface of roots developing large shallow "pox" marks, led to the discovery that the disease is due to a plasmodium and that there are two modes of infection. One is by the plasmodium as a whole, causing large shallow pits; the second is by means of swarm spores, which enter the growing-points of stems or roots and cause the formation of deep circular pits, when the infection reaches the main root. The swarm spores first entering a growing-point go through a rapid development in the outer host cells, passing through an ameboid and a plasmodial stage. During the plasmodial stage a large number of nuclei are formed by mitotic division. The plasmodium then forms a heavy-walled cyst in which hundreds of spores are developed. The swarm spores are liberated within the cyst, which breaks down and releases the spores, when a further infection of host cells occurs. The infection spreads rapidly to the main root, causing a pit or "pox" scar. When the pit has reached the limit of its development the plasmodium assembles and breaks out, migrating into the soil. A secondary infection by swarm spores in small immature pits, causing extensive blister-like elevations in the skin of stored sweet potatoes, has been observed. White potatoes are also subject to the disease.

The formation of a heavy-walled cyst containing several hundred swarm spores separates this plasmodium from the now-recognized genera of the Plasmodiophorales. Accordingly, the name *Cystospora batata* gen.

[1] A preliminary note.

nov., sp. nov. is proposed for this new organism. A more complete description of the organism and the histology of the disease will be published shortly. JOHN A. ELLIOTT

DELAWARE COLLEGE EXPERIMENT STATION,
September 18, 1916

THE SYNCHRONAL FLASHING OF FIREFLIES

IN SCIENCE for February 4, 1916, E. S. Morse, under the title, "Fireflies Flashing in Unison," mentions having seen fifty years before a striking instance of the synchronal flashing of fireflies. Morse again discusses briefly the same subject in SCIENCE for September 15, 1916. He states that he has never since observed this phenomenon in the flashing of these insects. McDermott, in SCIENCE for October 27, 1916, also discusses the question of fireflies flashing in unison.

The synchronal flashing of fireflies appears to be a very rare phenomenon in North America. So rarely does it seem to occur that one may consider himself fortunate if he has observed the phenomenon even once in a lifetime. The writer about twelve years ago observed a most remarkable instance of the simultaneous flashing of fireflies in Oxford, Mass. On the night this phenomenon occurred a heavy thunderstorm had recently passed over, followed by a profound calm. From time to time dazzling flashes of lightning illuminated the landscape. The air was very warm and humid, and fireflies became unusually abundant and active, especially in a low field adjoining some woods. Here thousands of these insects were sailing low over the ground, flashing incessantly as far as the eye could see. After a while a most remarkable synchronism in the flashing appeared to take place. From time to time, as if moved by a common impulse, great numbers would flash so closely in unison over the entire field that an extensive sheet of tiny light-points would gleam upon the vision for a moment—and then vanish. This remarkable synchronism in the flashing sometimes continued several times in succession, giving one the impression of alternate waves of illumination and darkness in the distance. At times the rhythmic impulse ceased for a considerable period over the entire field. At other times it appeared to take place only in large groups occupying particular areas of the field. Although the writer has given a great deal of attention to the flashing of fireflies during the last twelve years, synchronism in the flashing of these insects has never since been observed. Depending more or less upon atmospheric conditions, fireflies show considerable variation in the character of their flight and the flashing impulse. At times the insects seem loath to leave the low herbage. On certain evenings they appear to confine their flight over the fields largely to the lowermost stratum of the atmosphere; at other times they rise upward in myriads from the grass early in the evening and drift away in all directions toward the crowns of the trees. At such times the upward flight is frequently accompanied by a weak, prolonged emission of light so that the insects appear to be tiny, glowing sparks propelled upward by gentle air currents.

H. A. ALLARD

WASHINGTON, D. C.

QUOTATIONS

THE NEWCASTLE MEETING OF THE BRITISH ASSOCIATION

FOR the third time the British Association has held its annual meeting during the great war. There are some obvious reasons for suspending such meetings, to which brief reference has already been made on the previous occasions, and to which has been since added the further restriction of available members by the adoption of universal service. But there are also good reasons for "carrying on," the best of them being provided by experience. The meetings have been eminently successful, if success is properly gauged with due account taken of the difficulties. In using the word it is not implied that the numbers present were large compared with the average numbers in peace time: at Newcastle the tickets sold were indisputably below that average—even much below it: we must think rather of what might have been, under the deplorable circumstances. The sections might have been empty, whereas they were well attended, in

some cases specially well attended even by any standard. It is a fair inference that many of the absentees were such as do not usually attend the section, preferring the lighter entertainments of the meeting. At Newcastle there were no general excursions, though the anthropologists made a sectional excursion to the Roman Wall; and there were no entertainments beyond a thoroughly enjoyable reception by the Lord Mayor on one evening, and a very pleasant garden party given by Miss Noble and Mrs. Cochrane. There is no need to determine now whether the severe economy in general gatherings need be permanent: in our present mood we naturally regard their more frivolous characteristics with disfavor. But such general gatherings, where those usually separated in calling and locality may meet for interchange of ideas, have an undoubted value which may be trusted to reassert itself when the time comes. At present we have neither much inclination nor much time for them, seeing that the whole meetings have been reduced in length.

Further, in estimating the success of the meeting, we must remember the actual difficulties to be overcome, especially by the city of Newcastle, and all who worked so devotedly in its interests. The invitation was given before the war, and it would have been quite reasonable to withdraw it under the entirely unforeseen conditions, even in the interests of the guests themselves, who might not have cared to visit an east coast "fortified town" just now. But in March last, after the necessary limitations and modifications had been frankly stated, and a courteous enquiry had been made and answered, the invitation was cordially confirmed; and from that moment no more was said of the heavy load of anxiety which those responsible for the success of the meeting must have carried with them continuously until the concluding words were spoken. —From an Oxford Note-book in *The Observatory*.

THE STATE COLLEGE OF AGRICULTURE AT CORNELL UNIVERSITY

THAT the State College of Agriculture at Cornell University is successfully solving the great problem of agricultural education is visibly evident from the fact that in a dozen years the enrollment of students in the college has increased ten-fold. Already the college of agriculture is the largest college in Cornell University, and the authorities and friends of the university share the hopes of the faculty of agriculture for a continued increase in the attendance and steady improvement and growing success in its work.

The motive force behind this great movement for a more satisfying country life and a better agriculture is the conviction that properly trained men and women must be placed on the farms and in the rural communities. Education and science are the hope of the farmers as they have already proved the boon of manufacturers and transporters. Men and women of vision and well-disciplined minds are the prime agents in accomplishing progress in every field of human activity whether intellectual, economic or material.

Under the terms of the Smith-Lever Bill New York state will in 1923, and annually thereafter, when the appropriations provided for will have reached their maximum, receive from the federal government $170,000 on condition that the state of New York provide an equal amount for cooperative extension work among the farmers of the state. Cornell University being the federal land grant college of New York is the agent by which this extension work is to be carried on.

While the federal government has thus generously encouraged education and investigation in agriculture and the extension of the results of scientific investigation to farmers on their own farms, many of the state governments have shown no less zeal for the betterment of the farmers and the improvement of conditions of farming within their own borders. Among these states New York stands conspicuous. The State College of Agriculture and Veterinary Medicine at Cornell University as well as the state experiment station at Geneva are visible evidences of the wisdom with which, in this respect, the state has been governed.

Briefly and broadly expressed, the State

College of Agriculture at Cornell University exists for the benefit of the farmers. It is a college of *agriculture*, it is not an institution of general education.

The New York State College of Agriculture has stood in the forefront among the agricultural colleges of America. Its work, however, has only just begun and vast possibilities are opening up for the future. The extent to which the college can realize these possibilities and the rate at which it can continue to progress will depend largely on how adequately its growing needs are met by appropriations from the state of New York.—President J. G. Schurman in his Annual Report.

SCIENTIFIC BOOKS

Catalogue of the Fresh-water Fishes of Africa in the British Museum. Vol. IV. By G. A. Boulenger. London, British Museum (Natural History).

The fourth volume completes the account of the fresh-water fishes of Africa, based on a collection of over 15,000 specimens, and including 1,425 species. In addition to the enormous collection of the British Museum, on which the work is primarily based, the author examined many specimens belonging to other museums, and did everything possible to make a complete survey of the subject on the lines laid down. Like other British Museum "Catalogues," this is in reality a monographic revision of the whole group of animals discussed.

When noticing a former volume, we had occasion to refer to the magnitude and importance of Mr. Boulenger's labors in this field. It may perhaps be opportune to call attention to the extraordinary value of such a worker to any museum or country. We are not only amazed at the amount of work which may be accomplished by a single man, but we observe how he secures the cooperation of collectors, men who can not themselves do technical work in zoology, but are more than glad to furnish materials to those who can make such good use of them. Collecting in tropical Africa is always difficult and often hazardous, but many enthusiasts have searched the rivers and lakes of that continent for Mr. Boulenger, proud to be partners in so great an undertaking. The aid thus rendered has been fully and exactly recognized in publication, following the excellent methods long ago established by the British Museum. In our own National Museum the staff in certain departments has always been inadequate, while the possibilities of development have never been appreciated by Congress. Curatorial work on the collections is, of course, the first necessity; but it is not realized that it would be a splendid investment to secure experts to take charge of those divisions of zoology and botany which have been least developed, and which superficially appear to stand least in need of attention. The Museum, employing one man, really secures the services of many, who become collaborators and contributors of specimens from all over the world. In 1870, only 255 species of fresh-water fishes were known from Africa; who could have guessed what intensive work would bring forth? The materials gathered together can not be sold; it is impossible to accurately define their value in money, but it ought to be sufficiently apparent that the work pays, whether we regard the tangible or intangible results.

The volume under review begins with the Carangidæ, and includes the more specialized or higher families of fishes. More than half, however, is occupied with "Addenda," descriptions of the numerous species discovered during the publication of the work. The additional species belong mainly to the Cyprinidæ, Siluridæ and Characinidæ, as might have been expected. The already enormous genus *Barbus* receives very many additions. The plan of the work does not permit any reference to the proposals by C. Tate Regan and others to break up the so-called family Characinidæ; nor does it allow the inclusion of those illuminating discussions of the geographical distribution of the various families which the author himself has published elsewhere. Although scales are used continually in the keys and descriptions, there is no reference to the microscopical characters they present and no word or line indicates that they have ever received anything but the most superficial at-

tention. This is not a matter of lack of space; it results from rigidly following a predetermined plan, and ignoring everything which does not fall within the artificially limited scope of the enquiry. It was the same attitude which caused Sir Geo. F. Hampson, in the great catalogue of moths published by the British Museum, to refuse to recognize or mention the genitalic characters of the segregates of *Apamea nictitans,* although the facts, accompanied by prepared slides, were freely offered for his use. This extreme rigidity of method has certain advantages; it permits consistency of treatment, and allows the author to base the whole classification on characters which he thoroughly understands and is accustomed to use. It may also be urged with reason that it is impossible to study or describe *all* the structures of animals, and consequently it is necessary to make a selection. Still another argument may be based on the fact which modern comparative morphology is daily making more apparent, that the minute study of almost any important structure in a long series of species will afford a fairly sound basis for classification. Thus Dr. Asa C. Chandler, in his remarkable account of the microscopical features of feathers, lately published by the University of California, shows that if we possessed *only* feathers, the birds otherwise being wholly unknown to us, we could construct from them a rational classification of the class Aves. Similarly, Dr. Edna Mosher, in a study of the Lepidopterous pupa published this year by the Illinois State Laboratory of Natural History, is able to construct a classification of moths and butterflies on the pupæ alone. It is noteworthy, however, that while the feathers of birds and the pupæ of moths essentially confirm existing systems of classification, they afford some discordant facts, which at least suggest the propriety of certain modifications. Precisely the same thing is true of the scales of fishes. The development of organs and characters in animals does not present an even front; evolution within the limits of the organism is unequal in degree and rapidity, and hence each set of structures teaches some lessons which the others do not supply. No single worker, dealing with a large group, can take the time to search for all these illuminating footnotes to the book of nature. It is the work of the comparative morphologist to uncover them; and while the professional taxonomist may properly express an opinion whether in this or that case they are significant for his purposes, he can not safely look the other way, pretending that they do not exist.

T. D. A. COCKERELL
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J. L. Pagel's Einführung in die Geschichte der Medizin in 25 akademischen Vorlesungen. Zweite Auflage. Durchgesehen, teilweise umgearbeitet und auf den heutigen Stand gebracht von KARL SUDHOFF in Leipzig. Berlin, 1915, in 8°. Verlag von S. Karger, pp. i–xv + 1–616.

Within the past twenty years there has been developed, especially in Germany, an interesting subject—the history of medicine. There has been great progress in the development of this subject in all of its phases and much light has been thrown on many new lines of intellectual endeavor. There are two journals which are devoted exclusively to the history of medicine and related subjects. These are: "*Archiv für die Geschichte der Medizin,*" edited by Karl Sudhoff, in Leipzig, of which eight volumes have appeared, and the "*Zoologische Annalen, Geschichte der Zoologie,*" edited by Max Braun, 1905 to date, of which likewise eight volumes have appeared.

The two men involved in the production of the book the title of which is given above have been largely concerned in the development of the history of medicine, together with their co-workers Puschmann, Neuburger, Töply, M. Holl and others. It is an important event when the editor of the "*Archiv für die Geschichte der Medizin*" issues a second edition of Pagel's *Einführung*. After a lapse of seventeen years this important work is issued in a second edition, which is increased in scope and brought down to date by Karl Sudhoff. The work was first issued by Pagel in 1898 as Part I. of a two-volume work; the second part being: "*Historisch-medicinische Bibliographie*

für die Jahre 1875–1895." This later part has not been included in the new edition.

In regard to the scope of the work, Sudhoff, in the preface to the second edition, says: "Dass ich persönlich unter 'Geschichte der Medizin' etwas mehr verstehe als eine medizinische Literaturgeschichte: eine kulturgeschichtliche Erfassung der heilenden Kunst und Wissenschaft im Gesamtleben der Zeiten, dürfte bekannt sein, kommt aber hier nicht in Frage, wo es sich um eine 'Einführung,' um ein Lehrbuch der Medizingeschichte handelt."

Pagel, likewise, has a broad idea of the importance of the history of medicine, for he says: "Die ganze moderne Medizin baut sich auf dem Gedanken der Entwicklung auf."

As the title indicates, the volume was based originally on a series of lectures, more or less popular in nature, but all of them readable. The lectures are a little more thorough in their content than those of Ernst Schwalbe[1] and the additions made by Karl Sudhoff raises it out of the ranks of a volume of lectures and forms the greater part of my excuse for reviewing the work in this place.

The work proceeds along well-defined and usual lines, taking up serially the development of medicine in the various countries. There is nothing new or startling in the method of their presentation, but the facts are essentially all there and the addenda and references by the editor make the book a most useful one for the beginning student.

The first lecture deals with the beginnings of the healing art and discusses the nature of medical work in ancient and modern China and Japan and among the Aztecs of Mexico. The second lecture discusses medical history among the peoples of ancient India, Babylonia, Egypt, Palestine and the other countries of Asia Minor. The succeeding four lectures are devoted to the medical lore of the Greeks, with one entire chapter given to Galen.

The lectures from this point take up the development of modern medicine, and the later lectures are given a more biographical cast as various eminent men exerted an influence over various phases of medical work. Interpolated throughout these pages there is given by Sudhoff, in a way to be found nowhere else, the sources of information, recent developments of each special topic and recent literature, but not in such abundance as to be tiresome to the general reader. So that in addition to being a volume of very readable lectures it may also be used as a work of reference of no small importance, though of course not attempting to rank with the Handbücher of Pagel and Häser. It will appeal to the general reader as being free from a number of technicalities and will be found to be one of the best one-volume presentations of medical history of recent years.

[1] "Vorlesungen ueber Geschichte der Medizin," Jena, 1909.

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THE ZERO AND PRINCIPLE OF LOCAL VALUE USED BY THE MAYA OF CENTRAL AMERICA

Historians of mathematics refer to the vigesimal system of the Maya[1] of Central America and southern Mexico, but, to my knowledge, no historian conveys the information that the Maya, in the writing of numbers, employed symbols for zero and the principle of local value. Added interest attaches to this matter from the fact that the Maya appear to have done this earlier than any one else. My attention is called to this achievement of the Maya by a recent book issued by the Government Printing Office in Washington, entitled *An Introduction to the Study of the Maya Hieroglyphs*, by Sylvanus Griswold Morley, 1915. This publication constitutes Bulletin 57 of the Bureau of American Ethnology. Nearly all the information contained in this article is drawn from that source.

The age of the Maya inscriptions and codices is a matter of vital interest and, as yet, of considerable doubt. It is known that

[1] See, for instance, M. Cantor, "Geschichte der Mathematik," Vol. I., 3d ed., 1907, p. 9.

all dated monuments had their origin within 400 years of each other. The Maya had an accurate system of chronology, but the difficulty lies in establishing a correlation between their chronology and our own. Authorities differ on this point. Take one of the monuments, called Stela 9, in the ancient town of Copan in Honduras. Mr. Morley summarizes the various conclusions regarding the date for Stela 9 thus:[2]

> Professor Seler's date of 1255 B.C. for this is by far the oldest; Mr. Bowditch's date, A.D. 34, comes next. My own correlation assigns a date to this monument somewhere between the years 284 to 304 A.D., which an assumption made by both Mr. Bowditch and Professor Seler in their correlations would narrow to A.D. 294. Finally, the passage from The Book of Chilan Balam of Mani, as I have amended it, gives the date of this monument as A.D. 282.

The Ethnologist-in-Charge, F. W. Hodge, in his "Letter of Transmittal" of Morley's book expresses himself thus:

> The earliest inscriptions now extant probably date from about the beginning of the Christian era, but such is the complexity of the glyphs and subject-matter even at this early period, that in order to estimate the age of the system it is necessary to postulate a far greater antiquity for its origin.

For purposes of comparison, let us recall the dates of the number systems of the Babylonians and Hindus. The early Babylonians possessed the principle of local value, but, so far as now known, did not possess a zero. About two centuries B.C. they did have a zero-symbol, which was "not used in calculation, nor does it always occur when units of any order are lacking."[3] They did not employ it systematically in writing numbers and not at all in performing computations. The Hindus certainly did not use their zero-symbol systematically in their decimal number-system before probably the sixth century A.D.; the earliest undoubted occurrence of our zero in India is A.D. 876. Mr. G. R. Kaye[4] mentions A.D. 595 and A.D. 662 as dates when, as claimed by some, Indian figures were known; "on the other hand it is held that there is no sound evidence of the employment in India of a place-value system earlier than about the ninth century."

In view of this, special interest attaches to the occurrence of zero-symbols and the principle of local value among the inhabitants of the flat lands of Central America, at a period as early as the beginning of the Christian era, if not much earlier. It would seem that in this invention, the Maya in Central America possessed priority over the Asiatic peoples by a margin of five or six centuries.

The Maya number system is remarkable for the extent of its early development. Records of Maya calendars and chronology are numerous and have been successfully deciphered. In fact, "it must be admitted that very little progress has been made in deciphering the Maya glyphs except those relating to the calendar and chronology; that is, the signs for the various time periods (days and months), the numerals, and a few name-glyphs; however, as these known signs comprise possibly two fifths of all the glyphs, it is clear that the general tenor of the Maya inscriptions is no longer concealed from us."[5] As far as known, the Maya used their numeral systems only in the counting of time, as it arose in their calendar, ritual and astronomy. Many numbers that are found in inscriptions and codices occur in connection with signs, the meanings of which have not yet been ascertained. Hence, after the meanings of more glyphs are deciphered, it may be found that the numeral system had much wider application than is evident at present.

Of the several Maya numeral notations we briefly describe the one which is of greatest interest to mathematicians on account of its embodying the principle of local value and the use of symbols for zero. It is found in Maya codices, but not in their inscriptions. The

[2] S. G. Morley, "The Correlation of Maya and Christian Chronology," *American Journal of Archæology*, Vol. 14, 1910, p. 204.

[3] D. E. Smith and L. C. Karpinski, "Hindu-Arabic Numerals," 1911, p. 51.

[4] G. R. Kaye, "Indian Mathematics," Calcutta and Simla, 1915, p. 31.

[5] S. G. Morley, *op. cit.*, p. iv.

ratio of increase of successive units in this and the other fully developed Maya systems was not 10, as in the Hindu-Arabic system; it was 20 in all positions except the third. That is, 20 units of the lowest order (*kins*, or days) make one unit of the next higher order (*uinal*, or 20 days), 18 uinals make one unit of the third order (*tun*, or 360 days), 20 tuns make one unit of the fourth order (*katun*, or 7,200 days), 20 katuns made one unit of the fifth order (*cycle*, or 144,000 days), and finally, 20 cycles make one *great cycle* of 2,880,000 days. It has been contended by some archeologists that in Maya inscriptions, not 20, but 13, *cycles* constitute a *great cycle*, but in the Maya codices all archeologists agree that the only break in the vigesimal system lies in the relation that 18 uinals equal 1 tun. Proceeding now to the notation, as found in the codices, we find symbols 1 to 19, both inclusive, expressed by bars and dots. Each bar stands for five units, each dot for 1 unit. For instance,

1 2 4 5 7 11 19

The values of the bars and dots are *added* in each case. The zero, which plays a leading part in the notations found on inscriptions as well as those on codices, is represented in the codices by a symbol that looks roughly like a half-closed eye. This zero and the symbols for 1 — 19 in the Maya vigesimal notation correspond to the symbols 0, 1, 2, . . . 9 in our decimal notation. In writing 20, in the Maya codices, the principle of local value enters for the first time. It is expressed by a dot placed over the symbol for zero. The numerals are written, not horizontally, but vertically, the unit of lowest order or value being assigned the lowest position. Accordingly, 37 was expressed by the symbols for 17 (three bars and two dots) in the kin place and one dot, representing 20, placed above the 17, in the uinal place. The number 300 is expressed by three bars drawn above the symbol for zero ($3 \times 5 \times 20 = 300$). The largest number which can be written by the use of only two places or positions is $17 \times 20 + 19 = 359$. To write 360, the Maya drew two zeros, one above the other, with one dot higher up, in third place. Using three places to represent *kins*, *uinals* and *tuns*, they could write any number not larger than 7,199. Proceeding in this way the Maya wrote numbers in very compact form. The highest number found in the codices is 12,489,781. It occurs on page 61 of what is known as the "Dresden Codex," a fiber-paper booklet that was reproduced facsimile by Professor E. Förstemann in 1880 and 1892. The symbols representing this number occupy six different places, one above the other. Proceeding from bottom up, the symbols in the six places are, respectively, one dot, three bars, two bars and three dots, two bars and four dots, one bar and one dot, four dots. Thus the numerals in the six places are, respectively, 1, 15, 13, 14, 6, 4. Applying to these the principle of local value, they represent altogether: $1 + 15 \times 20 + 13 \times 18 \times 20 + 14 \times 20 \times 18 \times 20 + 6 \times 20 \times 20 \times 18 \times 20 + 4 \times 20 \times 20 \times 20 \times 18 \times 20 = 12{,}489{,}781$. From these illustrations it is seen that the Maya used the zero and the principle of local value consistently in the writing of numbers reaching into the millions.

The second numeral notation that was fully developed and employed by the Maya is found in their inscriptions. It employs the zero, but not the principle of local value. Special glyphs are employed to designate the different units. It is as if we were to write 1203 as "1 thousand, 2 hundred, 0 tens, 3 ones." We omit a detailed description of the system. The ratios of successive orders of units are the same as in the preceding, with the exception, perhaps, of the unit of the sixth order. In this second notation, that unit may rest upon the ratio 13, instead of 20, as we stated above.

The numerals in the Maya codices appear to the present writer to disclose traces of an imperfect quinary system, as seen in the use of the bar to represent 5. Similarly it seems to the present writer that there is a trace of an imperfect decimal system in Maya numerals found in inscriptions, where 16 — 19 are represented by two symbols, one symbol for 10 and the other for 6, 7, 8, 9, respectively.

We shall not attempt to describe the Maya chronology. It is a complicated and highly developed system. The larger part of Morley's book is devoted to the description of it. His exposition is admirably clear. No specimens of Maya computation are extant. Maya records contain only the results of computation. It is evident that considerable reckoning is involved in Maya chronology. The Maya had a sacred year of 260 days, an official year of 360 days and a solar year of 365 + days. The fact that $360 = 18 \times 20$ seems to account for the break in the vigesimal system, making 18 (rather than 20) uinals equal to 1 tun. Apparently, the Maya found the lowest common multiple of 260 and 365, or 18,980. In their calendar 18,980 days consituted the "Calendar Round," a period of 52 years which is "the most important period of Maya chronology." Using this period, the Maya developed an elaborate system of counting time, "wherein any date of the Calendar Round could be fixed with absolute certainty within a period of 374,400 years."

FLORIAN CAJORI

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SPECIAL ARTICLES

THE FOCUS OF THE AURORAL STREAMERS ON AUGUST 26, 1916

IN a recent number of SCIENCE[1] the remarkable auroral display of August 26 was described by Professor C. C. Nutting, as observed by him at Lake Douglas in northern Michigan. The phenomenon was reported to have been of unusual intensity and beauty. The appearance of streamers in the southern sky was particularly noted, as well as the fact that the auroral glow prevailed around the entire vault of the heavens, causing the earth to be illuminated without shadows.

This aurora was widespread because it was also seen in northern New York, in New Hampshire, in Nova Scotia, and over the Gulf of St. Lawrence. According to a letter in the current issue of SCIENCE,[2] it was observed as far south as Martha's Vineyard, Mass. In each case the characteristics so well described by Professor Nutting were observed.

It has been reported as far west as Washta, Ia., by F. S. Carrington.[3] In this case the streamers in the northeast passed to the south of the zenith, and the glow in the southern horizon reached to about 30°.

The aurora evidently extended eastward to the British Isles, because a bright display was reported by Mr. W. F. Denning at Bristol, England, from 2 to 4 A.M., August 27. The streamers were observed to an altitude of 70° in the northern sky, and moved rapidly from west to east.[4]

It was seen at Eskdalemuir, Dumfriesshire, from 9 P.M., August 26, to past midnight, accompanied by considerable disturbance of the magnets at the Kew Observatory. The magnetic storm commenced suddenly at 7:45 P.M., August 26. It was observed at Seskin, Waterford, in Ireland, from 10:05 to 10:40 P.M., August 26, the streamers in the northern sky stretching to within 20° or 30° of the zenith.[5]

The aurora was seen on the north shore of Prince Edward Island by the writer, who noted some of its interesting features; among which was the location of the apparent focus of the auroral streamers with respect to some readily identified stars. To this particular attention was paid.

GENERAL FEATURES OF THE AURORA

The writer was on a wide stretch of water and observed the beginning of the aurora, which occurred at 8:15 P.M. Atlantic time, the sky being perfectly clear. The glow at first showed dimly in the southern sky, but rapidly increased in intensity until the entire southern portion of the vault of the heavens was pierced by pale greenish lance-like streamers. Those overhead terminated in a well defined focus, southeast of the zenith, as shown in Fig. 1.

For some minutes there was no evidence whatever of an aurora to the north. Later, streamers rose in that section, and soon the

[1] N. S., Vol. XLIV., October 6, 1916.

[2] N. S., Vol. XLIV., October 20, 1916.

[3] *The Guide to Nature*, November, 1916, p. 191.

[4] *Nature*, Vol. 97, 2444, August 31, 1916.

[5] *Nature*, Vol. 98, 2447, September 21, 1916.

entire sky had the appearance of a luminous umbrella; the well defined center of which was southeast of the zenith. A short time after the commencement of the aurora a band-like corona stretched across the greater portion of the heavens from east to west through the focus, as shown in Fig. 2, and at another time a large irregular corona formed around that region of the sky.

Hampshire. In the report it was stated that the aurora covered the southern sky and that the "umbrella" effect of the streamers showed a center a short distance south of the zenith.

It was seen also by Dr. J. A. Brown, professor of physics in the Syrian Protestant College, Beirut, Syria, who was on a lake in the Adirondacks, N. Y., and who described the display to the writer as a very remarkable one.

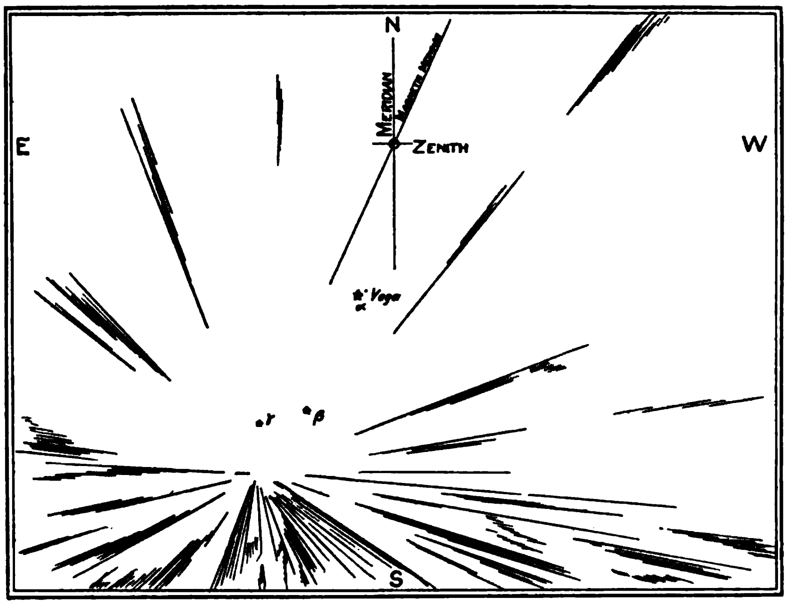

Fig. 1. Auroral focus as it appeared at 8:20 P.M., August 26, at Prince Edward Island. (*The heavens are shown as they appear when facing south and looking at the zenith.*)

The auroral glow showed the very rapid kaleidoscopic changes described by Professor Nutting and the phenomenon was indeed inspiring on account of the unusual grandeur of the display. The color of the streamers as seen from Prince Edward Island throughout the entire evening was pale greenish; almost white, and at no time reddish or the intense light green frequently observed.

The earth appeared as if illuminated by bright moonlight, except the striking effect due to the absence of all shadows, as already reported by Professor Nutting.

The aurora has been reported in a letter to the *Monthly Evening Sky Map* by Mr. Frank C. Porter, who observed it at Ashland, New

His attention was directed to the aurora with special interest on observing the streamers in the southern sky.

The occurrence of the aurora borealis in the southern half of the heavens appears to be an infrequent phenomenon; at least in the temperate zone of North America.

An aurora was observed by the writer some years ago on September 11 at Grand Lake, Maine, which completely arched the southern sky with bright streamers. That display began about eight o'clock in the evening and lasted several hours. At first, no auroral phenomenon appeared north of the zenith, but as the evening advanced a faint glow was seen in the north. Particular note was made at the

time that the streamers in the southern as well as the northern sky appeared to meet a considerable number of degrees to the southeast of the zenith, but the exact location was not observed. One fact of similarity between these two appearances of the aurora in the southern sky was that in both cases the streamers appeared in the southern half of the heavens before any indication of an aurora showed in the north; as if some condition of the atmosphere susceptible to an auroral display had been reached to the south before it has been reached to the north of the point of observation, indicating some progressive change in the atmosphere from south to north.

the heavens could apparently be located within an area of the size of the full moon, which has an angular diameter of about one half degree.

Professor Nutting, describing the aurora in his article in SCIENCE, states that the "focus of the spectacle was the zenith itself." So it might appear with a casual glance, being near the zenith, and with nothing to mark that point. His paper is mainly concerned with other features of the display and is an excellent description of them, but the position among the stars toward which the streamers converged was evidently not noted.

The place of observation where the aurora was observed by the writer was about fourteen miles north of Charlottetown, Prince Edward Island, which is at latitude 46° 13′ 58.48″, longitude 63° 7′ 23.64″ according to values provided by the Department of Mines, Canada. The latitude of the place of observation is taken as 46° 26′ and longitude as 63° 8′. Mr. C. S. Brainin, of Columbia University, has kindly computed the position of the zenith with respect to the stars at the time of observation, which gives that point as shown in Fig. 1. The zenith distance of the

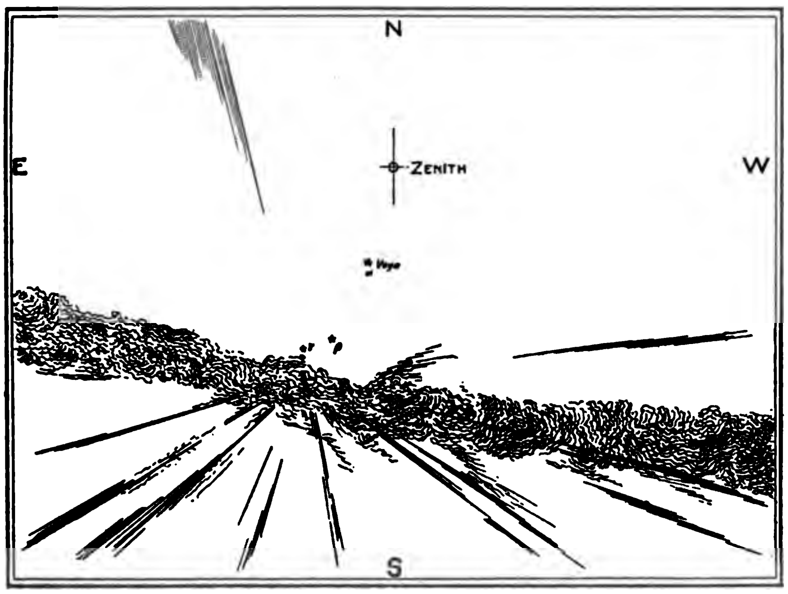

FIG. 2. Auroral corona forming a luminous band across the sky passing through the focus as observed about 8:25 P.M.

THE FOCUS OF THE STREAMERS

The position of the apparent focus of the streamers near the zenith is of special importance owing to the relation of the direction of the streamers to the direction of the lines of force of the magnetic field of the earth. The point of focus was located about two degrees south of the star γ Lyra at 8:20 o'clock Atlantic time. The time was later verified through the local telegraph office. The spot in

auroral focus thus determined is 16° 54′ and the azimuth of that point, 22° 42′ E. The accuracy of the observation, however, can not be considered better than about one degree.

It is of course desirable to compare these values with the magnetic elements of the place of observation.

The Canadian government is now engaged in making a magnetic survey, and has made observations at nearly five hundred stations in Canada, but none recently on Prince Edward Island. Fortunately, the department of terrestrial magnetism of the Carnegie Institution of Washington has been able to provide values for the magnetic declination and inclination at Charlottetown, P. E. I., which were determined in 1908. They are as follows:

Declination 23° 46′.4 W. for the epoch 1908.8
Inclination 74° 59′.3 N. for the epoch 1908.8

Dr. L. A. Bauer has kindly given me the average rates of annual change of both the declination and inclination during the period from 1908 to 1916, as well as the direction of the isogonics and isoclinals for 1916.8, which makes it possible to give the declination at the place of observation as 24° 36″ W., and the inclination 75° 04′ N. A comparison of the focus point of the aurora and the above values is as follows:

Magnetic Field Auroral Focus	Declination, 24° 36″ Azimuth, 22° 42′	Inclination, 75° 04′ Altitude, 73° 06′
Difference......	1° 54′	1° 58′

While the accuracy of the determination of the auroral focus is only one degree, it is about as close as other determinations. The observation may be unique, owing to the fact that the focus was formed by streamers in the southern as well as in the northern sky, that the point in the heavens was determined from the focus itself, and not from a corona, and at a station as far south as latitude 46°.

Elaborate observations have been made during several Arctic expeditions of the azimuth of the summits of aurora arcs, but there seems to be no definite coincidence between the azimuth measured and the magnetic meridian, the angular differences being often many degrees, sometimes as great as 20° to 40°. No explanation has been given for this anomaly. The corona center has been measured at a number of stations at high latitudes, and as a rule has been found to agree with the magnetic zenith to within about one degree.

At Cape Thorsden (78° 28′ N. Lat.) the mean of a considerable number of observations made the angle between the auroral focus and the lines of the earth's magnetism 1° 7′, the magnetic inclination being 80° 35′, while the coronal center had an altitude of 79° 55′. Somewhat smaller differences have been reported at other far northern stations.

The height of this aurora may be taken at about sixty-five miles above the surface of the earth, if the results of Carl Störmer's auroral expedition are accepted, as recorded in *Nature*,[6] and reproduced in Fig. 3. Approximately 2,400 of these determinations have been transferred from the chart in Professor Störmer's report and used to make the curve in Fig. 4. It is seen that the maximum height for the aurora according to this set of observations is between 55 and 80 miles.

The position of the auroral focus thus shows the direction of the field of terrestrial magnetism at about sixty-five miles above the surface of the earth.

The lines of force of the earth's magnetism as determined by the auroral focus should curve downward and pierce the earth's crust at about the place of observation, 14 miles north of Charlottetown. It is therefore proper to compare the direction of the magnetic field shown by the auroral streamers with the magnetic declination and inclination at that place. The observed values of both declination and inclination at 65 miles altitude are less than the values at the surface of the earth (each by about two degrees). This is exactly what should be expected since above the surface of the earth the lines of force curve towards the south pole as in the case of any magnet. Assuming the aurora to be at this height, the point on the surface of the earth directly beneath the apparent focus was about 14 miles

[6] *Nature*, Vol. 97, No. 2418, March 2, 1916.

southeast of Charlottetown and on Prince Edward Island at approximately latitude 46° 6′, longitude 62° 53′. The auroral streamers near the zenith may be regarded as approximately parallel and their apparent focus is of course due to perspective.

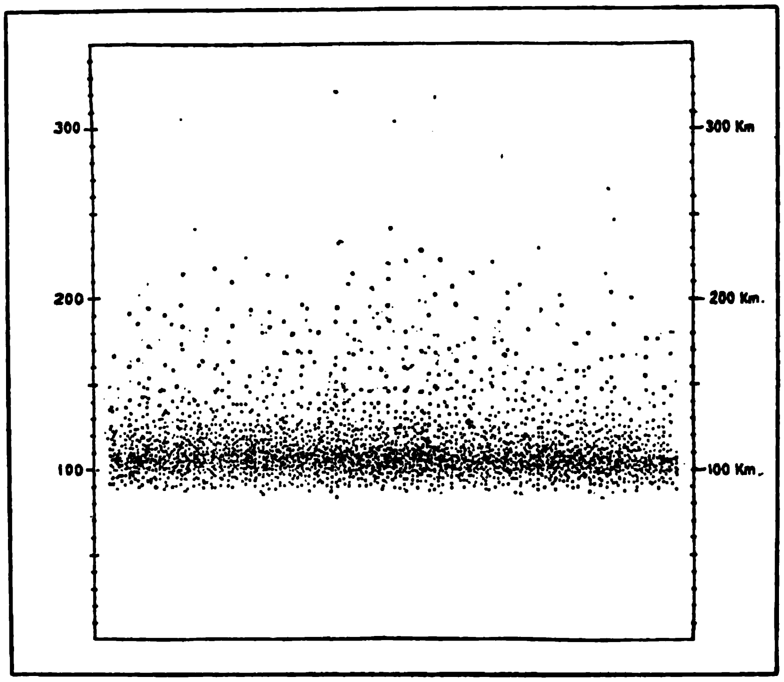

Fig. 3. The altitude of aurora borealis seen from Bossekop during the spring of 1913. Each calculated attitude is marked by a dot and the several hundred simultaneous photographs of aurora from the stations—Bossekop and Store Korsnes—(mutual distance 27½ kilometers) gave about 2,500 determinations of height, which are seen above. (Reprinted from *Nature*.)

HEIGHT OF THE AURORA AND THE METEOR TRAIN ZONE

One of the results of the study of meteor trains has been the discovery of a definite meteor train zone between 50 and 70 miles' altitude. When certain large meteors pass into this zone, a train is observed to remain in the track, apparently composed of self-luminous gas and which frequently remains visible for half an hour. Nitrogen has been found to assume a true phosphorescent state similar to the afterglow of zinc sulphide.[7] It has been observed to remain visible in the laboratory for 20 minutes. There is much evidence in favor of the view that the meteor train is phosphorescent nitrogen and formed in the same zone in the atmosphere which is susceptible to electrical discharges and results in the aurora.

In Fig. 4, curve *A*, the heights of 2,400 observations of the aurora made by Carl Störmer's expedition are shown. Curve *B* shows the heights of the middle portion of 30 meteor trains, and curve *C* gives the heights of the lower ends of 21 meteor trains.

The initial intensity of gas phosphorescence has been found to be proportional to the third power of the gas pressure;[8] hence it is to be expected that meteor trains would show a predominance at slightly lower elevation than the aurora, as indicated in Fig. 4.

[7] C. C. Trowbridge, *Phys. Review*, Vol. XXVI., June, 1908.

[8] C. C. Trowbridge, *Phys. Rev.*, Vol. XXXII., February, 1911.

It is thus evident that there is a zone in the atmosphere susceptible to electrical conductivity beginning at about 50 miles from the surface of the earth as shown by both the auroral height determinations and those of focus of the aurora of August 26 were at a height above the earth's surface not far from sixty to sixty-five miles.

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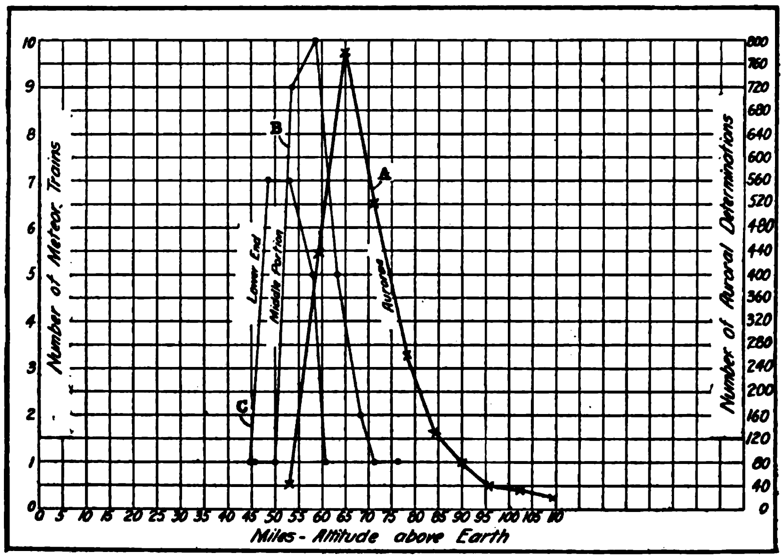

FIG. 4. Comparison of the heights of the aurora, determined by Carl Störmer's expedition at Bossekop during the spring of 1913, and the heights of meteor trains. In both cases the altitudes were determined by triangulation from two stations.

Curve *A*—2,400 determinations of the heights of the aurora.

Curve *B*—the heights of the middle portion of 30 meteor trains.

Curve *C*—the heights of the lower end of 21 meteor trains.

the meteor trains. The conducting layer in the earth's atmosphere which has been much discussed by those interested in the propagation of long electric waves is usually given as at an altitude of 35 to 40 miles by various writers on wireless telegraphy, as based on some theoretical deductions of Professor J. J. Thomson. The results given above seem to show that the main conducting layer of the atmosphere is considerably above the altitude heretofore accepted, and is at a height of from 50 to 70 miles.

The general agreement between the recently determined values of auroral heights and the altitude limits of the meteor train zone shown in Fig. 4 is very significant, and there is thus good evidence that the streamers forming the

THE NINETEENTH MEETING OF THE AMERICAN ASTRONOMICAL SOCIETY

THE nineteenth meeting of the American Astronomical Society was held in the Sproul Observatory of Swarthmore College, Swarthmore, Pennsylvania, on August 30 to September 2, 1916. This was the first meeting held east of the Allegheny Mountains since 1911, intervening meetings having been held in Pittsburgh, Cleveland, Atlanta, Evanston, and San Francisco.

It has been the policy of the society for some years past to hold its meetings at some one of the active observatories of the country. Astronomers are dependent, in a considerable measure in the nature of their contributions, on the equipment of their various observatories, and for a large part on the character and size of the telescope. It is, therefore, always of interest in the meetings to

see the observatories and instruments in detail; and by following the policy adopted the society will have eventually visited, and become directly acquainted with, the principal observatories of the country. The Observatory at Swarthmore College has been recently constructed, through the generous gift of the Honorable William Cameron Sproul. The principal instrument is a 24-inch refractor, constructed by the John A. Brashear Company. It is being devoted, for the most part, to photographic observations for the determination of stellar distances, and already has contributed, through the hands of the director, Professor John A. Miller, and his able staff of assistants, a considerable series of results of very high quality. This instrument was at the disposal of the members of the society on each evening, and we viewed with it star clusters, nebulæ, double stars, and the planets Jupiter and Uranus.

Swarthmore College is in beautiful surroundings; and the beauty of its campus was well matched by the generous hospitality extended to the society. Relaxation from the rather severe scientific program was provided in a reception by Professor and Mrs. Miller, a Pennsylvania Country Supper in the home of Senator Sproul, and in an excursion by automobile through the suburbs of Philadelphia to Valley Forge. The return from Valley Forge was made through Bryn Mawr to Haverford College, where we were welcomed by President Isaac Sharpless, and where tea was served by some of the ladies of the faculty. We visited here some of the buildings, and naturally took great interest in the well-found observatory. Continuing the ride, we arrived at dusk at the Flower Observatory of the University of Pennsylvania at Upper Darby. Here we were greeted by Provost Edgar F. Smith, Professor Eric Doolittle and his wife, and Professor C. L. Doolittle and his wife. We were the guests of the University of Pennsylvania for dinner, which was spread under the trees on the observatory grounds. Unfortunately it was cloudy in the evening, so that we were unable to have the expected opportunity of observing with the 18½-inch refractor. We did have opportunity, however, of inspecting the various instruments of this well-equipped observatory, and to see the work on double stars which Doolittle is so ably conducting. The return to Swarthmore was made late in the evening.

The following members of the society were in attendance:

Leah B. Allen,	Willis I. Milham,
A. T. G. Apple,	John A. Miller,
S. G. Barton,	S. A. Mitchell,
L. A. Bauer,	C. P. Olivier,
A. F. Beal,	Edison Pettit,
Harriet W. Bigelow,	E. C. Pickering,
E. W. Brown,	John H. Pitman,
Annie J. Cannon,	John M. Poor,
C. A. Chant,	A. W. Quimby,
W. A. Cogshall,	E. D. Roe,
R. H. Curtiss,	H. N. Russell,
C. L. Doolittle,	Frank Schlesinger,
Eric Doolittle,	Frederick Slocum,
J. C. Duncan,	M. B. Snyder,
W. S. Eichelberger,	Joel Stebbins,
Philip Fox,	Hannah B. Steele,
Edgar Frisby,	H. T. Stetson,
Caroline E. Furness,	Florence J. Stocker,
W. E. Harper,	Helen M. Swartz,
Margaret Harwood,	John Tatlock,
François Henroteau,	Stephen D. Thaw,
Wm. T. Herriott,	Robert Trümpler,
Kiyotsugu Hirayama,	A. B. Turner,
Mary M. Hopkins,	F. W. Very,
Charles J. Hudson,	A. van Maanan,
Louise F. Jenkins,	J. van der Bilt,
C. C. Kiess,	W. R. Warner,
O. M. Leland,	D. T. Wilson,
Walter A. Mátos,	W. L. Wright,
Paul Merrill,	C. C. Wylie.

New members to the society were elected as follows:

H. C. Bancroft, 412 Taylor Avenue, West Collingswood, N. J.
Ruth D. Bannister, Dearborn Observatory, Evanston, Ill.
Arthur Floyd Beal, Albion College, Albion, Mich.
Martha Clare Borton, Princeton Observatory, Princeton, N. J.
Frederick Lyons Brown, Dearborn Observatory, Evanston, Ill.
Allan B. Burbeck, North Abington, Mass.
Clifford Charles Crump, Carleton College, Northfield, Minn.
Edith Eleanor Cummings, Laws Observatory, Columbia, Mo.
Clinton Harvey Currier, Brown University, Providence, R. I.
William Ewart Glanville, St. Peter's Rectory, Solomons, Md.
Edward Gray, 2635 Channing Way, Berkeley, Calif.
William LeRoy Hart, Harvard University, Cambridge, Mass.
François Henroteau, Detroit Observatory, Ann Arbor, Mich.
William T. Herriott, Allegheny Observatory, Pittsburgh, Pa.
Kiyotsugu Hirayama, Astronomical Observatory, Tokyo, Japan.
Arthur S. King, Solar Observatory, Pasadena, Calif.
Ora Miner Leland, 150 Triphammer Road, Ithaca, N. Y.
C. B. Lindsley, 855 East Ridgeway Ave., Cincinnati, Ohio.
Walter A. Mátos, 309 College Ave., Swarthmore, Pa.
Harriet McWilliams Parsons, Vassar College, Poughkeepsie, N. Y.
Jesse Pawling, Naval Observatory, Washington, D. C.
Edison Pettit, Washburn College, Topeka, Kansas.

David B. Pickering, 81 South Burnett St., East Orange, N. J.
William Francis Rice, Wheaton College, Wheaton, Ill.
Robert Trümpler, Allegheny Observatory, Pittsburgh, Pa.
J. van der Bilt, Utrecht Observatory, Utrecht, Holland.
Reynold K. Young, Dominion Observatory, Ottawa, Canada.

At the last meeting, the election of officers took place.

President—E. C. Pickering.
First Vice-president—Frank Schlesinger.
Second Vice-president—W. W. Campbell.
Treasurer—Annie J. Cannon.
Councilors for 1916–18—E. W. Brown, J. S. Plaskett.

The following officers continue in service:
Councillors, 1915–17—Edwin B. Frost, Joel Stebbins.
Secretary—Philip Fox.

It was voted to hold a meeting of the society in conjunction with the American Association, at its coming general quadrennial meeting in New York, on December 26 to 30, 1916. Further, accepting the invitation of Professor Benjamin Boss, it was voted to hold the annual summer meeting of 1917 at the Dudley Observatory, in Albany, N. Y.

A committee composed of Messrs. W. W. Campbell, chairman; E. E. Barnard, F. B. Littell, Frank Loud, S. A. Mitchell and Edison Pettit, was appointed to further and facilitate cooperation for the observation of the coming favorable solar eclipse of June 8, 1918. The Committee on Meteors was enlarged by the appointment of C. P. Olivier, secretary; E. E. Barnard, W. J. Humphreys, F. R. Moulton and W. H. Pickering. A committee to consider instituting the grade of Associate Membership was also appointed. The members of this committee are: Messrs. Frank Schlesinger, chairman; C. A. Chant, G. C. Comstock, Philip Fox, W. T. Olcott and E. D. Roe.

Other committees of the society made reports on their work, but only one led to a motion recommending a course of action by the society. This was the Committee on Standard Equinoxes for Use in the Publication of Star Positions. The recommendation of this committee, which was adopted by the council and recommended for practise by members of the society, was "that in any publication involving star positions no equinoxes should be used intermediate between the years 1900 and 1925." If the plan of widely spaced standard equinoxes is adopted, it will greatly reduce the amount of labor now involved in the treatment of the star positions given for such a multiplicity of equinoxes.

The great European War, which has affected profoundly the whole world, has put its blighting hand on our society, in the death of Professor Karl Schwarzschild. At the last meeting of the society, the following resolution was unanimously adopted:

WHEREAS: In the death of Karl Schwarzschild on May 11, 1916, many of the members of this society have lost a warm friend, the society itself one of its most eminent members, and astronomy a brilliant and remarkably versatile contributor:

Resolved: That the society record in its minutes its sense of deep loss, and that copies of this resolution be engrossed and sent to Mrs. Schwarzschild, and to the Astrophysical Observatory at Potsdam.

Aside from committee reports, the scientific program consisted of fifty-two papers. The titles are given here, in the order of presentation:

1. F. Slocum: The Van Vleck Observatory.
2. E. W. Brown: The Progress of the New Lunar Tables.
3. Annie J. Cannon: Peculiar Spectra Found in Preparing the New Draper Catalogue.
4. C. P. Olivier: The Meteor System of Winnecke's Comet.
5. E. C. Pickering: Proper Motion of Stars in the Zone $-10°$ to $-14°$.
6. J. A. Miller: Summary of the Sproul Observatory Parallax Work.
7. Hannah B. Steele: The Parallax of Certain Binary Stars.
8. John H. Pitman: Choice of Comparison Stars in Parallax Determinations.
9. Philip Fox: First Results on the Dearborn Observatory Parallax Program.
10. K. Burns, W. H. Meggars, P. W. Merrill: Determination of Wave-lengths by Interference.
11. A. van Maanen: Remarks on the Motion of the Stars in $h\chi$ Persei.
12. W. S. Adams: Recent Stellar Spectroscopic Results.
13. C. J. Hudson: Irregularities in Refraction.
14. A. Hall: The New Repsold Micrometer for the 26-inch Refractor of the Naval Observatory.
15. H. L. Alden: Calibration of the McCormick Observatory Photometer Wedge.
16. S. A. Mitchell: Parallax Work at the McCormick Observatory.
17. R. H. Curtiss: The Widths of Hydrogen Emission Lines in Class B Spectra.
18. R. H. Curtiss: Some Structure Variations in Hydrogen Emission Lines in Class B Spectra.
19. H. N. Russell, Mary Fowler, Martha C. Borton: Photographic Observation of Eclipsing Variables.

20. H. Shapley: Colors of the Brightest Stars in Seven Globular Clusters.
21. H. Shapley: Notes on the Spectra of Cepheid Variables.
22. Leon Campbell: Cooperation in Variable Star Observing.
23. J. Kunz and J. Stebbins: Progress in Photoelectric Photometry.
24. F. H. Seares: The Color of the Polar Sequence Stars.
25. F. H. Seares: Distribution of Color in the Spiral Nebulæ.
26. Edison Pettit: Circumstances of the Solar Eclipse of June 8, 1918.
27. E. P. Hubble: On the Variable Nebula N. G. C. 2261.
28. F. W. Very: Lunar and Terrestrial Albedoes.
29. F. W. Very: The Spherical Albedoes of the Planets.
30. L. A. Bauer: Note on the Rotation Periods of the Planets.
31. C. C. Crump: Preliminary Note on the Spectrum of Gamma Lyræ.
32. H. N. Russell: On the Capture of Comets by Planets.
33. F. W. Very: Examination of "New Evidence" on the Solar Constant.
34. F. W. Very: Planetary Evidence in Respect to Solar Radiation.
35. F. W. Very: The Radiant Properties of the Earth from the Standpoint of Atmospheric Thermodynamics.
36. R. E. DeLury: The Effect of Haze Spectrum on Spectrographic Determination of the Solar Rotation.
37. R. E. DeLury: Note on a Supposed Variation in the Solar Rotation.
38. S. G. Barton: The Interrelations of the Asteroid Elements.
39. H. N. Russell: The Visibility of Jupiter by Daylight.
40. E. E. Barnard: A Small Star with the Largest Known Proper Motion.
41. W. W. Campbell, J. H. Moore: The Spectral Type and Radial Velocity of Barnard's Proper Motion Star.
42. F. G. Pease: Rotation and Radial Velocity of the Spiral Nebula N. G. C. 4594.
43. C. O. Lampland: Measurements of the Spiral Nebulæ N. G. C. 4254 and 5194 for Motion.
44. H. D. Curtis: Forms of Planetary Nebulæ.
45. Eric Doolittle: An Extension of Burnham's Catalogue of Double Stars.
46. J. A. Parkhurst: The Bases of Photographic Stellar Magnitudes.
47. Sarah F. Whiting: Diaries of the Tulse Hill Observatory.
48. V. M. Slipher: Spectrographic Observations of Nebulæ.
49. W. W. Campbell and J. H. Moore: Spectrographic Observations of Motion in the Planetary Nebulæ.
50. V. M. Slipher: Spectral Evidence of a Persistent Aurora.
51. C. E. St. John, Louise W. Ware: Systematic Errors in Rowland Table for Close Pairs of Solar Lines.
52. C. E. St. John: On the Mutual Repulsion of Solar Lines.

Abstracts for these papers are given in a somewhat fuller report of the meeting in the current numbers of *Popular Astronomy*, and only the main lines of the papers are commented on here. Those which pertain to details of observation are possibly sufficiently well described by the title.

It is very gratifying to hear from Professor Brown that the printing of the New Lunar Tables, computed along the lines of his complete Lunar Theory, is progressing rapidly, and that in the Ephemerides for 1923, we will, for the first time, have the results from them.

In the report by Miss Cannon on the peculiar spectra found in the observations for the new Draper Catalogue, we find that this catalogue, which is to be of immense service, also is nearing completion.

Mr. Olivier, following lines laid down by Schiaparelli, points out a new coincidence between a meteoric system and a comet's orbit.

Papers were presented by Miller, Steele, Pitman, Fox and Mitchell, dealing with stellar parallax results. Few movements in American astronomy are progressing more favorably than the campaign for extension of our knowledge of stellar distances. Many observatories are taking part in the campaign, and all are now contributing results. From the Sproul Observatory was a report on the parallax of 64 objects; the University of Virginia reported on the parallax of 96 stars; the Dearborn Observatory on 4 stars.

The paper of Mr. Adams was also of interest from the stellar parallax point of view, in that he here gives results from his very original and important spectroscopic method of estimating stellar distances.

Spectroscopists in general will be interested in the work of Burns, Meggars, and Merrill, who are extending the determinations, by interference methods, of wave-lengths of lines spaced at short intervals through the spectrum which may well be

used as standards in other determinations of wave-lengths.

The fact that certain stars vary in brightness has of course long been recognized, and there are several papers here presented bearing on stellar magnitudes or on variables, by Leon Campbell, who comments on the rich and important contributions being made by associated amateurs; by Russell, who brings out some exceedingly important points from his treatment of eclipsing variables; by Shapley; by Kunz and Stebbins, who are developing their photo-electric cells; by Seares, who continues his contributions on the standard photometric field of the polar sequence; and by Parkhurst, who gives the results of his valuable experience on the bases of photographic stellar magnitudes. From various sources, important contributions are now being made, showing that the variation of light is not alone confined to the integrated light, but that marked changes of the character of the spectrum are also involved. At this meeting there were papers by Shapley, by R. H. Curtiss, by Adams, and by Miss Cannon, on this very fundamental matter.

In other directions where constancy had come to be regarded as perhaps the general condition, we are now finding marked changes. Mr. Hubble's paper on a variable nebula presented photographs of this remarkable object, showing that it had undergone astonishing change of form. Whether or not there is any relation between the change of form and the light variation of the associated star is not yet revealed. In 1914, at the Evanston meeting of the society, Slipher showed his first spectroscopic results, proving the rotation of certain nebulæ. At this meeting, he presented further evidence on the rotation of nebulæ, and contributions of similar nature were presented also by Campbell and Moore, and by Pease. Lampland gives evidence of rotation of two nebulæ from measurements of direct photographs.

It was following the presentation of Pettit's paper on the Circumstances of the Solar Eclipse of June 8, 1918, that the committee to further the cooperation in observing the eclipse was appointed.

Very's papers on the albedoes of the Moon, the Earth and the Planets, and the discussion which followed, particularly that by Mr. Russell, did much to clarify the ideas on this matter, where the results by given observers have been at variance and very perplexing.

Professor Barnard has recently found a faint star of about the eleventh photographic magnitude which, in individual proper motion, exceeds that of any heretofore recognized. In addition to Barnard's paper on this star, Campbell and Moore and also Adams contributed certain observations on its motion.

There have been very perplexing deviations in the values for the rotation of the Sun, as determined by various observers using the spectroscopic method, and also from observations made at different times by a single observer. The papers by DeLury give a sufficient and positive explanation of these deviations, and leave no reason for supposing that the rate of rotation of the Sun is variable from season to season.

In a paper on the extension of Burnham's Catalogue of Double Stars, Doolittle summarizes the work, which he has carried forward since Burnham turned over his manuscript and material to him. In doing this work, Doolittle is in a position to state at once whether any double star suspected of being new by any observer had already been noted as such. He is also in a position to state what objects have been recently and sufficiently observed, and he offers to give information on either of these points to any one who may wish to profit by such service. Double star observers, to work efficiently, must have information, at least on the latter point, and to have available the information which Doolittle has at hand will minimize the labor which its duplication would otherwise necessarily involve.

At the conclusion of the meeting, the following resolution of appreciation of courtesies was adopted:

Resolved: That the American Astronomical Society express to the President and Board of Managers of Swarthmore College, its thanks for the courtesies extended to the members of the society during the meetings at Swarthmore. The society desires also to express its appreciation of the numerous arrangements made for their comfort and convenience by Professor Miller and President Swain, and of the manner in which these have been carried out by the matron of Wharton Hall and others who have assisted in looking after the welfare of the visitors.

Resolved: That the thanks of the society be extended to Senator William Cameron Sproul, to the citizens of Swarthmore, to the president and trustees of the University of Pennsylvania, and to the president and board of managers of Haverford College for their hospitalities in connection with the visit of the society and its appreciation of the courtesies extended to its members.

Resolved: That the secretary be directed to communicate the substance of these resolutions to Presidents Swain, Smith and Sharpless, and to others who have assisted.

Philip Fox,
Secretary

SCIENCE

FRIDAY, NOVEMBER 24, 1916

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

IS THE EIGHT-HOUR WORKING-DAY RATIONAL?[1]

MAY I say at once that it is not my intention to consider the political aspects of the eight-hour problem? There should not be political aspects in a topic that is so preeminently a problem of science. Furthermore, considered as a problem of science, the eight-hour day is rarely viewed in its proper light. In the voluminous literature that has been published concerning it economic and social considerations have been too often paramount. Yet in an adequate analysis of it the real basis of the whole matter is physiological—the eight-hour problem is primarily a problem of physiology; if the physiological effects of any kind of labor are bad, the conditions of such labor ought to be changed. This is fundamental, and should precede any consideration of the economic and social effects of a change of conditions. This basic fact is continually overlooked.

The eight-hour day is the result of an evolution, beginning in human aspiration and fostered largely by humanitarian motives. That baser considerations, the desire to earn wages at the minimum cost of personal effort, impel many advocates of the eight-hour principle, can not be denied, but this need not blind us to the fact that there are higher grounds on which the problem can legitimately be discussed.

In the evolution of the eight-hour day England, of all countries, presents the most interesting history. Diligent search has failed to reveal the origin of the tra-

[1] Read before the Section on Industrial Hygiene of the American Public Health Association, Cincinnati, October 25, 1916.

ditional division of the diurnal twenty-four hours into eight hours each of work, recreation and sleep. It is said that the customary duration of the working-day of the fifteenth century was eight hours. Whether this be true or not, during the subsequent three hundred years all the evils of unrestricted labor flourished vigorously. At the beginning of the nineteenth century most English artisans were accustomed to work from eleven to fifteen hours in the day. No delicate physiological tests were needed to demonstrate what such a system was doing to destroy the vital mechanisms of men, women and children. The results were sufficiently obvious, and the next one hundred years were marked by a series of struggles between workers and humanitarians on the one side, and capitalists on the other, in which progress toward a physiological working-day was gradually, though slowly, made. After sporadic reductions of the working-period to twelve hours or less, a ten-hour movement was succeeded in time by a nine-hour movement, and by the middle of the century the eight-hour day had been definitely proposed. It was won first, not in the mother-country, but by the artisans of Melbourne, Australia, in 1856, and this date marks the beginning of achievement of the eight-hour movement. In the United States agitation in its favor began immediately after the close of the Civil War, stimulated, no doubt, by the great extension of industrial work which then occurred. Thus, since the middle of the nineteenth century the eight-hour day has been the goal of labor. Such a day presupposes one day's rest in every seven and thus signifies a forty-eight-hour week. It is usually coupled, however, with an extra half holiday, which for the majority of persons would be taken on Saturday afternoon. In this manner the week's work would be reduced to forty-four hours, and this represents the present demand of the eight-hour movement. Partly by law and partly by private agreement between employer and employed the eight-hour day has been granted in recent years to one group of workers here and another there, usually localized groups and rarely including all the workers in a single industry of a single country. At the present time it has become legalized in our own country for public employees and employees on public works in the federal service and in thirty states and territories; for miners in the service of fourteen states; for employees in smelting and reduction works in nine states; for railroad telegraphers in six states; for employees in rolling, rod and stamp mills in five states; for employees in tunnels and in coke ovens in three states; for employees in blast furnaces, in cement and plaster mills, and those who work under high air pressure in two states; for employees in electric light and power plants, glass works and irrigation works in one state; and for employees in day's work, unless otherwise stipulated, in nine states. In 1913 of the 1,276,048 employees constituting the shop force of the 51,118 factories in the state of New York, 354,641, or 28 per cent., worked 51 hours or less in the week. The eight-hour day will doubtless ultimately be achieved by a very large proportion of the world's workers in the more highly civilized countries.

What should determine the duration of daily labor? Here I would place, as of first importance, the physiological effects of the work and, as secondary and subordinate factors, its economic and social features.

The physiological effects of labor are now so well known as to require here only brief mention. The expenditure of energy by the bodily organs involves chemical and physical changes in them which, if con-

tinued, leads to the physiological state of fatigue. Fatigue is characterized chemically by the diminution within the acting tissues of chemical substances that have previously been stored within the living cells and either serve as sources of energy or are otherwise essential to tissue activity; and by the appearance within the living cells of other chemical substances, products of katabolic action, which are known as fatigue substances and react upon the tissues to decrease their power of responding to stimuli. If the same amount of work as before is then to be performed by the organs, the nervous system must send to them more powerful impulses, and when this becomes no longer possible the amount of work decreases. Fatigue substances spread from the place of their origin to other organs and react upon them, and thus the activity of one physiological mechanism, such, for example, as a neuromuscular mechanism, fatigues others. In fatigue the senses are less acute; attention is less sharply focused; the power of discrimination is lessened; the muscles are weakened; the quickness and the accuracy of muscular action are decreased; glandular secretions seem to be decreased; the heart-beat may be slowed or, in extreme cases, possibly quickened and irregular; the blood vessels of the skin are dilated and draft an undue quantity of blood away from the brain. In fatigue the sense of weariness obtrudes and oppresses; but it can not be too strongly emphasized or too often reiterated that the feeling of fatigue is a very uncertain index of the presence of a measurable degree of the fatigue of the tissues. The feeling may, indeed, appear just at the time when its warning note is really needed; but it may sound an unduly early and a false alarm; and again, and especially when other potent psychic influences inhibit it, its coming may be unduly postponed. It is a fitful, capricious thing, and this fact is too often overlooked in the consideration of industrial fatigue.

All these physiological changes may be within normal limits, and by rest the irritability of the tissues can then be readily restored and the freshness of sensation and the vigor of mind and muscle can be brought back. But if the work has been too strenuous or too long-continued, if the chemical changes in the tissues have gone too far, or if rest has been unduly curtailed, fatigue passes over into a pathological state which is known as exhaustion and is far less easily recovered from. Not only is the power of achievement then further diminished, but susceptibility to specific disease is increased. There may be a general neurasthenia or other diseases of the nervous system, including nervous affections of the bodily organs. The will may be weakened, and resistance to immoral temptations may be lessened. Intemperance is one of the common results of bodily exhaustion, and even crime itself finds here one of its prolific sources. Resistance to infectious disease may be diminished, apparently because of a diminution of the protective antibodies. Thus, excessive fatigue may bring in its train many disastrous sequelæ with much physical and moral misery. The seeds of this more serious state are often sowed in industrial work, when the conditions of labor and living are such that a residuum of the fatigue of one day is carried over to the next and from day to day there is a cumulative, even if slight, diminution of physiological powers.

Let us develop a little further this topic of the physiological effects of labor. Laboratory experiments have demonstrated that the degree of fatigue of a muscle in a given time varies in accordance with both the amount of the weight lifted and the rapidity with which stimuli are sent to the tissue. Increasing the weight, or making

the muscle contract more rapidly, increases the degree of fatigue in a given time and, if continued, brings on earlier exhaustion. These facts have their counterpart in industrial work, for fatigue here too depends on the intensity and the rapidity of repetition of the individual acts performed by the laborer. In general it may be said that the introduction of so-called labor-saving machinery has diminished the intensity and increased the rapidity of repetition of the laborer's acts. Lifeless machines now often lift the heavy weights once raised by human muscles. Other lifeless machines, intricate and automatic, relieve the laborer of much of his former light muscular work. But these same machines need to be tended by human agencies and set the pace for human activities, and the tendency is ever toward increasing the quickness and the constancy with which sense-organs, brain, spinal cord, and muscles must act.

The introduction of periods of rest while a laboratory experiment with a muscle is in progress diminishes the fatigue of the moment, aids recuperation, and delays the oncoming of exhaustion. This is demonstrated very perfectly in each of us several times in a minute, since each beat of the heart is followed immediately by a resting period of sufficient length to enable the cardiac muscle completely to recuperate from the fatiguing effects of the previous contraction. The beneficial effects of similar resting periods in industrial labor are shown by the custom, not uncommon since the striking demonstration of the late Mr. Frederick Taylor in the lifting of heavy iron pigs, of giving workers occasional brief intervals of freedom from their tasks. The defenders of the twelve-hour duration of work in blast furnaces attempt to justify their attitude by the contention that the workman actually works but a fraction of the whole time on duty. A timely and striking instance of the value of frequent resting periods is reported by the British Health of Munition Workers Committee:

> Two officers at the front recently, for a friendly wager, competed in making equal lengths of a certain trench, each with an equal squad of men. One let his men work as they pleased, but as hard as possible. The other divided his men into three sets, to work in rotation, each set digging their hardest for five minutes and then resting for ten, till their spell of labor came again. The latter team won easily.

Fatigue is modified by the external conditions under which the work is performed. Thus, it was found by Scott and myself that when an animal had been exposed for six hours to an atmosphere with a temperature of 91° F. (33° C.) and 90 per cent. relative humidity the fatigue of the animal's muscles came on more rapidly and their working power was diminished by about one quarter. Certain industrial occupations too require their work to be performed in the midst of excessive heat and humidity and thus afford the conditions of an early oncoming of fatigue and exhaustion. Doubtless other environmental conditions, such as excessive or deficient light, noise, and gross mechanical vibrations, influence the fatigue process, but these have not been adequately and experimentally studied. Attention might here be called to the suggestive little book recently published by the Gilbreths, which shows by what easy and simple means unnecessary fatigue may often be avoided.

It is obvious that if, under any given conditions of intensity and rate of labor and of its environmental features, the working-day is of such a length as to bring about the evil physiological results here mentioned, the surest way to avoid them is to shorten it. There exist few, if any, studies devoted to the specific physiological effects of a reduction of the working-hours, and this gap in our knowledge it is desirable to fill; but that the general health of

laborers has thereby been benefited is testified to by many observers, and this is equivalent, in other words, to an improved physiological status among them.

The economic argument, that industry can thrive only with a long working-day and that any curtailment of it would be destructive, is perennial and has often been potent in discussion. This argument can be met very effectively by pointing to the effects of shortening the working-period on the quantity and quality of output in manufacture. These effects are so uniform that it may be stated as a general law that upon reduction of the daily hours of labor the average quantity of the output of the individual worker undergoes a preliminary decrease, then a return to the original amount, and finally a permanent increase. This augmentation of output occurs, not only with a reduction to ten, but even to eight, hours. Instances of this are numerous. Thus, the very careful study by Professor Abbe of the effects of reducing the working-day in the Zeiss Optical Works in Jena from nine to eight hours shows an average increase of about three per cent. in the daily output of the employees. A certain steel works in England reports that each of its machines turns out in eight hours the same amount of work formerly produced in nine hours. In the steel-sheet and tin-plate trades of South Wales it is stated that after the change from the twelve- to the eight-hour day the increase of output in the rolling-mills amounted to twenty, and in the open-hearth melting process to twelve and one-half, per cent. In the year following the introduction of the eight-hour day into some of the coal mines of South Yorkshire it was reported that the production was "greatly in excess of what was ever produced by an equal number of men when the men worked twelve or thirteen hours." In the mining of bituminous coal in the state of Illinois during the three years previous to a reduction, in 1897, of the working-day from ten to eight hours the average amount of coal turned out daily by each individual was 2.72 tons and during the subsequent three years 3.16 tons, an increase of 16 per cent. The president of a granite-cutting company which had kept for many years a careful record of each employee's work, writes in 1912 that the system

> shows that the same man under identically the same conditions, accomplished more, of exactly the same kind of work when he was working nine hours, than he did when he was working ten hours, and again when the hours were reduced to eight hours this same man accomplished still more in an eight-hour day than he did in a nine-hour day, or a considerable amount more than he did when the day was ten hours long.

A German proprietor of glass-works reports that in a very short time after the reduction of the working-day from twelve and eleven to eight hours "there was produced, without increase of staff, as much as before the reduction"; and a proprietor of glass works in the north of France says:

> I must acknowledge that the men produce just as much, if not more, in their seven and a half hours' actual work than during the ten-hour day that preceded it.

At the Engis Chemical Works near Liége, where a very exact study was made of the results of introducing the eight-hour day, it was reported that

> In an eight-hours' day (seven and one half hours' actual work) the same men at the same furnaces with the same tools and raw material have produced as much as before in a twelve-hour day (ten hours' actual work).

A very significant comparison of the effects of long and short hours was made in connection with the building in the same years of two of our battleships, the *Louisiana* and the *Connecticut*. The *Louisiana* was built at Newport News by a private company working its men ten hours a day; the *Connecticut* was built at the Brooklyn

Navy Yard under the eight-hour system. In a report on the progress of the work during the first nineteen months it is stated by the compiler:

No other factor is considered than the productive ability of the two bodies of men doing exactly the same kind of work, using the same kind of tools and the same kind of material. It is practically all hand work, as the output of the automatic machines, with their speed limitations in production per hour, does not enter into this work.

The final computation showed that "the average production of a man per hour on the *Connecticut* exceeded by 24.28 per cent. the average production per man per hour on the *Louisiana.*"

Thus, the statistics reveal the utter fallacy of the notion that a longer working-day means a larger output. But the greater product of the short day, is, I submit, at first thought a very surprising fact, and its cause should be inquired into. It undoubtedly rests on a physiological basis, but without more accurate data any explanation of it must be only tentative. If man were a mere non-living automatic machine it would not occur. But his is a very different mechanism, in which that portion which does work, the effector machinery, is directed by a nervous system, which acts now consciously, now unconsciously, and through its receptor machinery is being continually influenced by external stimuli. All employers testify to the increased good-will, better spirit, and improved morale of the workers, that result from the shorter day. Because of these things the workers arrive more promptly at their places and tend to shirk less as the day proceeds. It is not inconceivable that in many cases there is a residuum of fatigue accumulated from the previous longer working-period, which must first be gotten rid of, and that thereafter the effector mechanism is less clogged. It is not improbable that realization of the brevity of the day and the early relief from toil act as a tonic. Such tonics exist: The spurt that occurs during the last hour of labor, irrespective of its length, is a commonly alleged, if not an attested, fact, and is ascribed to anticipation of release. Careful observation has shown too that other psychic influences increase markedly the output of a man's energy. All these varied influences acting upon the nervous system doubtless contribute to increase the expenditure of productive energy in the shorter time. Their combined influence is largely unconscious, and it is reported that the greater output is often a surprise to the workers themselves. That it has an origin largely in the action on the nervous system of such external stimuli as have been mentioned, is supported by the further facts that with the eight-hour day the workman makes fewer mistakes and spoils less material, and, in general, the quality of his work shows a distinct improvement. Thus, in the light of the facts of experience, the alleged economic necessity of the longer working-period because of the necessity of a greater output falls to the ground. The long working-period defeats its own object.

But the question may still be raised whether the greater output of the eight-hour day does not produce correspondingly greater fatigue and thus in turn defeat its object. I do not think so. If the day's fatigue were measured merely by the amount of energy transformed in producing the product, if here again man were a mere automatic machine, then surely there would be a direct ratio—the greater the product, the greater the fatigue, and nothing would be gained. But the case is not so simple as this. The day's fatigue is a sequel not simply of the amount of energy directly transformed in producing the material output. It is derived also from other sources—from the continuance of one bodily position, perhaps a strained position, from the noise and gross vibration of machinery,

from strained attention, from all those minor factors which Abbe has grouped together as sources of his well-named "passive fatigue." A shorter day eliminates these by so much and at its end leaves the worker so much better off than his longer-laboring fellow.

The argument for shorter hours that is most frequently put forward, by labor leaders at least, is the social one. Thus, Mr. Samuel Gompers says:

> The shorter workday is something more than an economic demand. It is a demand for an opportunity for rest, recuperation, development; things which make life more than mechanical drudgery.

This is undoubtedly a legitimate demand, but it in turn is dependent on the physiological requirements of the labor. If a man is worked beyond his physiological limit he is incapacitated for his duties to his family and to society. The history of labor has demonstrated this abundantly, and the experience of reducing the hours of labor has almost universally been followed by marked moral and social improvement, such as is shown by decrease in intemperance and crime, improvement in living conditions, greater efforts toward education, greater intelligence and greater industrial efficiency—all this in contradiction, not only to the vivid predictions of disaster pronounced by active and unprincipled opponents of the change, but to the fears of those who were well-meaning but timid.

As possible factors in determining the duration of labor I might mention the degree of skill required by the laborer and the degree of responsibility devolving upon him. These may rightly be potent in determining the amount of wage to be paid, since they are the accompaniments of greater intelligence and the results of greater training; but in their bearing on the length of the working-day they can be considered, it seems to me, only in the light of their physiological demands on the laborer. If the exercise of greater skill and the possession of greater responsibility deplete his physical and mental powers more quickly, he has earned a shorter working-period. If they do not, I see no reason why he should be granted time privileges.

Let me here summarize. Of the various agencies that have been considered as legitimate factors in determining the length of the working-day that which appears to me the most weighty is the physiological one, the physiological effects of the labor on the individual laborer. In the pursuit of his vocation as the employee of another every human being has a right to the preservation of his physiological powers, to the avoidance of excessive fatigue, to the continuance of his health. All questions of the percentage of financial profit, all questions of social demands or social opportunity, are subordinate to this. Moreover, this is essential to the other considerations mentioned, for only by the preservation of his health can the economic demands of his work be satisfied, only by this can he acquire and maintain skill and be worthy of responsibility. The whole question of the length of the working-day thus rests primarily on a physiological basis. In deciding the length of the working-day, therefore, the first and all-important query is: Is a long day physiologically detrimental to the individual? If so, it should be shortened. If the long day is not physiologically detrimental, then it is a fair question whether, because of his employer's interests or his own relations to society, his day should be long or short.

Is the reduction of the working-period to the eight-hour day a physiological necessity? Here two factors are to be considered: The characteristics of the labor and the capacity of the laborer. Different occupations differ greatly in their fatiguing power. Especially productive of fa-

tigue are those that are characterized by great muscular effort; unusual quickness or complexity of muscular action; single acts, however simple, that are monotonously repeated over long intervals of time; constant strain in attention or bodily position; and those in which the work is carried on in excessively crowded places, in excessive heat and humidity, in the midst of excessive noise, or under other unfavorable environmental conditions.

While different occupations thus differ in fatiguing power, not only in themselves, but in accordance with the external conditions under which the work is performed, there exist also great differences among human beings in their susceptibility to fatigue from a given occupation. This also is paralleled by individual muscles in a familiar laboratory experiment: Homologous muscles from different experimental animals or even from opposite limbs of the same animal, when stimulated at the same rate and lifting equal loads, do not usually perform the same amount of work. In industrial work every observant foreman who knows his men recognizes their individual differences in working power.

Neither the fatiguing effects of the manifold varieties of labor nor the susceptibilities of different laborers to fatigue have been studied with the degree and the care that the subjects demand, and with such paucity of knowledge it seems hardly possible at present to attempt to answer the question whether the reduction of the working-period to eight hours is a physiological necessity. The universality of the beneficial effects of such a reduction, however, argues strongly in favor of an affirmative reply. There has been no more clear-sighted observer and more logically analytic thinker on this topic than the late Professor Abbe, of Jena, in whom the breadth of scholarly culture was combined with a keen sense of efficient business organization. Ten years ago, after carefully analyzing the results of the reduction of the working-day in the Zeiss Optical Works and elsewhere, and considering the general condition of German industries, with their then prevailing long, and English industries, with their short, working-day, Abbe came to the conclusion that by far the majority of industrial workers do not reach their optimum in nine, and do not surpass it in eight, hours. With him the shorter day represents the physiological ideal and the goal for which industries should strive.

I am disposed to agree in general with Professor Abbe's conclusion for the present day. But it is evident, I think, that such a conclusion offers merely a temporary expedient. The establishment of a rigid and universal eight-hour system would probably prove not to be the best for all industries and for all individuals. In order to enable the wisest decision of the question to be made there is needed not mere opinions—not the opinions of employers, however broad-minded or narrow-minded; or of laborers, however industrious or indolent; or of labor leaders, however generous or selfish their ambitions; or of the laity, however philanthropic their motives; or of statesmen, whether they are impelled by a high idealism or by practical politics; but a rigidly scientific study of the question, through the medium of laboratory tests, of the physiological effects of different occupations and the physiological capacities of different laborers and a resultant classification, on a physiological basis, of work and workers. Such a study is not impossible, and it would afford the only basis for a rational and really intelligent solution of the problem. It would doubtless lead to the establishment of no rigid, but an elastic system, in which the work would be adapted to the worker, and the worker to the work. In one industry the duration of labor might be eight hours,

in another it might be more or less than eight hours. So too within a single industry one worker might labor longer than another. Such a solution could be made to satisfy both economic and social demands and lead to the maximum of individual and national efficiency.

I quite realize the difficulties inherent in putting into practise a system which does not recognize the magic eight hours as the ideal, and especially the still greater difficulties in the establishment of a system in which within a single occupation one person works longer than another. But I believe that these difficulties would prove less formidable if we would once get accustomed to the notion that individual capacity is the first criterion to be considered in deciding upon labor's duration. The adjustment of wages according to individual capacity I will leave to the economists.

In view of all this how fatuous was the action of the state of California in voting, in 1914, on the question whether the eight-hour day should be adopted! The proposition was defeated by about two to one, but the decision was necessarily a matter of sentiment, resting on no basis of adequate knowledge. An affair of such serious moment ought not to be decided by uninstructed popular feeling. The recent action of Congress in imposing, after a few hours' consideration, an eight-hour day upon railway employees can hardly be called more sagacious than the action of California. The Adamson bill, however, has little bearing on the general principle of the eight-hour day.

It is obvious that any formal regulation of the duration of daily labor is for those whose daily services are employed by others. By so much as a man rises above this stage he becomes free to choose his own working-time. It is a noteworthy fact that with the world's leaders, in industry, in finance, in professional life, the duration of the daily task is wholly secondary to its accomplishment. They are limited by no eight-, or ten-, or twelve- or sixteen-hour considerations. This indicates why such men become leaders. Laborers can learn a valuable lesson from this fact. The greedy employer who constantly saps the energies of those who are the medium by which he gains his wealth is to be condemned no more than is the "slacker" whose only guiding principles are a minimum of effort and a maximum of wage. Moreover, it is trite to say that the obligation rests upon the laborer that rests upon all men, so to use his free hours as to benefit himself, his family and society.

In conclusion I can not refrain from quoting, with warm approval of their sentiments and of their application to our own country, the recent significant words of Sir George Newman regarding British industries:

> Our national experience in modern industry is longer than that of any other people. It has shown clearly enough that false ideas of economic gain, blind to physiological law, must lead, as they led through the nineteenth century, to vast national loss and suffering. It is certain that unless our industrial life is to be guided in the future by the application of physiological science to the details of its management, it can not hope to maintain its position hereafter among some of its foreign rivals, who already in that respect have gained a present advantage.

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THE CARE OF PAMPHLET COLLECTIONS[1]

THE published articles pertaining even to the most restricted fields of science are scattered through a very large number of serial publications of which only the larger institutions of learning and research are able to possess complete sets. The high cost and large bulk of such series preclude their being owned

1 Contribution from the Museum of Vertebrate Zoology of the University of California.

by individual investigators or by the smaller institutions, and the general result is that the worker who desires to cover the literature of his particular field must have access to a collection of reprints and excerpts of such articles, gathered either independently, or by the institution with which he is connected. Thus most investigators have occasion to assemble and care for a pamphlet collection. The present paper considers some of the expedients commonly employed for this purpose and calls attention to a particular scheme which has been found satisfactory in the care of one collection.

Before a pamphlet collection can be efficiently used it must be properly arranged. The time thus spent will bring ample return in the added facility with which particular papers can be located when they are desired. In addition to this the exercise of a few simple precautions will do much to prolong the life and increase the usefulness of the pamphlets in a library. Dust, strong light and careless handling all help to depreciate the value of pamphlets. As time goes on and by one means or another, the copies of certain papers decrease in number; those which remain inevitably increase in value and become more difficult to obtain. It is needless to insist on the advisability of arresting these losses.

The methods in use for assorting and conserving pamphlets are various. Some collections are arranged to satisfy special needs, while others have no further purpose in their organization than that of general convenience. A popular method is to keep the reprints in flat piles on shelves. This, however, does not permit ready location, and removal of single papers from the pile involves a risk of tearing either them or the sheets adjacent to them. A second device is to place the pamphlets vertically on a shelf. This makes it possible to remove any desired paper without disturbing those adjacent to it. But unless there are frequent vertical partitions for support, the pressure exerted by the weight of the papers on either side makes the removal of thin pamphlets difficult. Both of these methods expose the collection to light and dust. A third method is to bind the pamphlets in volumes. This obviates the danger of damage by light or dust, but is still open to several serious objections. Chief among these is the difficulty of arranging the papers in a thoroughly convenient manner for ready reference. Of course where there are a number of papers by a single author these may be readily bound together chronologically in one or more volumes, but where the assortment is varied the problem of assembling for binding is more complex. All of the papers of one author may not be on hand when the binding is done; the contents of bound volumes can not be so readily indexed as can separate papers; and the papers contained therein can not be so easily laid out for study as when separate and unbound. A final objection to binding is that it involves considerably more expense than most of the other modes of filing.

A fourth method is to place the pamphlets in vertical filing cabinets. This economizes space as regards depth more than any of the other systems here mentioned but the cost of the containers is quite high—ranking close to or above that of binding the papers in volumes, according as the cabinet selected is of the rough "transfer" or highly finished type.

The last plan we shall notice is one that is probably in more general use than any other, namely, placing the pamphlets in narrow pamphlet cases. These are of three general types. The first resembles a small letter file with a hinged back which completely protects the contents from dust and light. This case is heavier and much more expensive than the others and is slightly more inconvenient to handle because of the necessity of opening the back when removing the contents. The second type has both top and back open and while it will accommodate pamphlets of widely different sizes it exposes portions of the papers to the harmful action of dust and light. The third type, a box open only at the back, seems by far the most convenient, as when pushed against a wall it is practically dust and light proof, though still permitting ready reference to its contents. Cases 12 inches high, 8 inches deep and 2½ inches wide, made of a

good weight of strawboard faced on the inside with white paper and entirely covered on the outside with black binder's cloth, have been found to give excellent results. These seem even more durable than cases with wooden tops and bottoms, as they have a slight "give" which seems to make them more lasting. A set of cases of this sort has been in constant use at the Museum of Vertebrate Zoology of the University of California for more than six years without showing appreciable wear. The size suggested will take all octavo publications and even the smaller quartos, and when completely filled the weight is still not too great for easy handling. Cases measuring more than 2½ inches in width are not satisfactory; they soon break to pieces under pressure of the greater weight of the material they hold. They often, moreover, hold too many papers for quick reference, while the narrower boxes permit of a finer classification. With the smaller size additional boxes may be interpolated as necessity arises, before a complete revision of the collection is required.

Three methods of filing the pamphlets of a collection are in general use; filing by subject, by author's surname, and by date of accession. For a small collection with which the worker is well acquainted and where there are few if any papers of such a nature as not to fall readily into one class or another, or in very large collections comprising papers on such distinct subjects as geography, geology and zoology, the subject classification is possibly the most convenient. But in large collections devoted to a narrower field the alphabetical segregation by authors is much more satisfactory. With papers so arranged and those of single authors in chronological order, no author index is needed. A third system, used somewhat more rarely, is to file pamphlets in the order of their receipt, giving them serial numbers, and maintaining both author and subject indexes for reference purposes. Such an arrangement has the advantage of not being disturbed by later accessions, these being added at the end of the collection. Under this system, however, the papers must be kept absolutely in order if they are to be found at all.

If cases are used to shelter the collection, some kind of case inscription is necessary, whatever system is adopted. When the cloth-covered cases described above are used, pieces of white paper, about 1¾ inches square, are pasted on the fronts of the boxes near their tops. On these labels are placed inscriptions designating the case contents. If the subject arangement is used, the title is made comprehensive enough to include all papers which are or may be filed in that case. If the author classification is used, a large initial letter is placed at the top and below it abbreviations indicating the names of the authors whose papers are filed in that case. Thus, for the case containing papers from Brown to Burns the inscription would be

B
Br-Bu.

If one author's papers are sufficiently numerous to require one or more complete cases their fronts bear his initial and name and an indication of the years covered by the papers included, thus:

O	O
Oberholser, H. C.	Oberholser, H. C.
1905–1914	1914—

When first arranging or when revising the arrangement of a pamphlet collection, sufficient room should be left in individual cases to anticipate considerable expansion—no case should be more than two thirds filled at first, save for a single author, unless the collection is already large and the expense of additional cases is an object for consideration. Thus a large number of papers can be added to the collection before it need be completely revised and relabelled.

Whatever method of arrangement is adopted some sort of finding index is necessary to make all the papers readily accessible. If any system other than that of filing by authors' names is adopted a catalogue of authors is needed. If the subject classification is adopted a card should be used for each author, the entries being made as follows:

Ridgway, R.
1892. Hummingbirds (Aves: systematic)
1897. Galapagos Is. birds (Faunal: S. Amer.)

The words in parentheses indicate where the paper is filed. When papers are filed by the accession method the same sort of entries are made in the author catalogue save that the serial number of the paper is included in the parentheses at the right. Thus:

Ridgway, R.
1892. Hummingbirds (642)
1897. Galapagos Island birds (1489)

Where papers are arranged by authors a subject index only is needed. For example, in the writer's own index for papers in vertebrate zoology there are included cards for systematic, and for geographic or faunal entries. Many papers require entry under both headings and some under even more. Thus, a paper by Ruthven, Thompson and Thompson, entitled "The Herpetology of Michigan," would be entered under "Reptiles," "Amphibians" and "Michigan." In this way the paper can be found under any of the three titles carded. The form of subject index entries is indicated by the following samples:

Reptiles
nw. Nevada—Richardson 1915
Michigan—Ruthven et al. 1912
San Jacinto Mts., Cal.—Atsatt 1913
Deer
Situation in Calif.-Clarke *in* Cal. F. & G. Comm. 1913
Farming in U. S.—Lantz 1914
Colorado River
Fishes—Gilbert and Scofield 1898
Birds and mammals—Grinnell 1914 (review Sumner 1915)

Papers often occur which are difficult of exact classification and it is well to have general headings under which these may be included, as for example "Birds," "Mammals," "Variation," etc. These titles may be subdivided, as the papers accumulate.

For all indexes the standard sized 3 by 5 inch cards of librarians and bibliographers are the most suitable. In entering the references a carbon ink such as Higgins Eternal is recommended because of its permanency of color and the uniformity of entries made at different times.

As a result of the great variation in the manner of placing the title, author's name and date of publication on the covers of reprints or pamphlets considerable time is lost in searching for these items when looking through a file. An easy way of overcoming this difficulty is to annotate the upper left-hand corner of the front of each paper with the author's name and initials, the date, and a catch title, in the form used by Professor E. L. Mark, of Harvard, thus:

Ruthven, A. G., et al.
:12
Herpetology of
Michigan

Rutter, C.
:08
Sacto.-San Joaquin
Valley
Fishes

Ridgway, R.
:92
Hummingbirds

The catch titles are arranged so that in looking down the left-hand margin the eye encounters the most important words first. With pamphlets so marked only a few seconds are required to secure any particular paper and it is often possible to locate it without removing the others from the case. Where there are a number of papers by a single author it is well to number them serially beginning with the oldest one. Then when a paper is withdrawn it can be quickly and correctly replaced by its number without having recourse to the date. For these annotations, as with catalogue cards, carbon ink should be used. Another method which has been used for the same purpose as these corner annotations is to underscore the author's name, the date and the title.

Serial publications are best kept in sets by themselves as they are received, but where the individual articles comprising a volume are issued in separate form these may be run into the general collection along with other pamphlets. Later on they can, if desired, be removed and bound in complete volumes. The writer has a considerable number of pamphlets relating to subjects outside his main line of work but which for one reason or another he desires to keep. These are arranged according to the names of their authors, and kept in a "reserve" file, where they can be

easily located. Many of them are complementary parts of complete volumes, the other papers of which are in his main pamphlet collection.

The date of receipt should always be written on the pamphlet as soon as it comes to hand. With some series no date of publication is given on the separate papers, and as they may have been issued in advance of the appearance of the complete volume, it often becomes important to know their dates of receipt, as in the case of papers describing new species of animals or plants.

In summary, then, the writer would recommend that a pamphlet collection be placed in cloth-covered cardboard cases open only at the back and not larger than 12 x 8 x 2½ inches, that it be arranged alphabetically by authors' names and chronologically under authors, that the corner of each pamphlet be annotated with the author's name, the date, and a catch title, and that a subject index be maintained to facilitate the location of particular pamphlets. A collection so arranged and housed renders the greatest amount of service, and is reasonably insured against deterioration.

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THE BRAIN COLLECTION OF THE U. S. NATIONAL MUSEUM

THE division of physical anthropology of the United States National Museum has been recently enriched by a most valuable accession of brains of some of the higher anthropoids. The accession consists of no less than eleven well-preserved brains of gorillas, and three chimpanzees. With the exception of two of the specimens belonging to young animals, the brains are in excellent condition for study. No less than six of the fourteen brains are those of adults, while most of the remaining, though not quite adult, are full-grown or nearly so.

A justifiable allusion may perhaps be made in this place to the rest of the collection of primate brains now in the division of physical anthropology, U. S. N. M.

The total collection, which was started by the writer thirteen years ago, counts now approximately 1,500 human and animal brains. Of these 223 are human, including 128 of other races than whites; while 348 belong to other primates. The latter are distributed as follows:

Gorilla	11	(5 adults)
Chimpanzees	6	(1 adult)
Orangs	36	(23 adults)
Gibbons and siamangs	55	(most adults)
Nasalis larvatus	17	" "
Baboons	22	" "
Presbytis	75	" "
Other Old World monkeys	64	" "
American monkeys	45	" "
Lemurs	17	" "

A large proportion of the above valuable material has been collected directly in or for the institution, and is in a very good condition for study. The number of adult anthropoid brains, excepting those of the chimpanzees, exceeds probably that of all other known collections of similar material not only singly, but even collectively.

Besides those of the primates, there are now in the collection the brains of 165 *carnivora* and *cetacea;* 50 *insectivora;* 266 *ungulata;* 81 *rodentia;* 47 *edentata* and *marsupialia;* and 287 *aves* and *reptilia.*

The whole collection, in common with others in the division and in the U. S. National Museum in general, is freely accessible for consultation to well-qualified scientific workers; and in suitable cases facilities could be extended for full elaboration and description of some of the series of specimens.

ALEŠ HRDLIČKA

PROGRAM OF THE YALE CHAPTER OF SIGMA XI FOR 1916–1917

THE meetings of the Yale Chapter of Sigma Xi for the present college year promise to be of unusual interest, for there are to be presented, instead of the usual mutually irrelevant papers, a series of lectures which together will constitute a symposium on the origin and evolution of the earth and its inhabitants. Each paper will be authoritative, the result of original research, and the series

after presentation is to be brought out in book form by the Yale University Press. The program follows:

I. The Genesis of the Earth. Professor Joseph Barrell. November 23.
II. The Earth's Changing Surface and Climate. Professor Charles Schuchert. December 13.
III. The Origin of Life. Professor Lorande Loss Woodruff. January 24.
IV. The Pulse of Life. Professor Richard Swann Lull. February 15.
V. Climate and Civilization. Dr. Ellsworth Huntington. April 20.

Thus there will be discussed: (1) The genesis of the earth and the rise of conditions necessary for the maintenance of life; (2) the surface changes, the great cycles of climatic change, and their cause or causes; (3) the origin of organic life on earth, the time, place and conditions necessary, and the changes undergone by matter to render it organic or possessed of life; (4) the march of organic evolution, not a slow process progressing at a constant rate of change, but rhythmic, the pulses or times of acceleration being coincident with and the direct outcome of the climatic and geologic changes already described. This includes the origin of man from his prehuman ancestry. (5) The recent climatic changes whose existence has been traced and recorded and which are found to have influenced the growth of civilization, the rise and migrations of peoples, and in some instances their fall from an estate of commanding importance. A prophecy of human destiny may here be given.

These lectures are to be given at the regular meetings of the society and therefore will not be open to the general public, but are to be the especial privilege of the members of Sigma Xi and a limited number of their friends to whom tickets of admission will be given. The lectures are to be held in Osborn Memorial Laboratory.

THE ENDOWMENT OF A MEDICAL SCHOOL AT THE UNIVERSITY OF CHICAGO

A CORRESPONDENT at the University of Chicago sends us the following information concerning the endowment of a medical school noted in the last issue of SCIENCE:

In outlining the plans and hopes of the University of Chicago at its recent quarter-centennial celebration President Harry Pratt Judson said that what was needed to complete a school of medicine at the university was provision for clinical work and a clinical staff at the Midway, and that in his judgment the first need was for a hospital wholly under the control of the university, for medical teaching and for medical research; and the second need was provision of adequate endowment, in order that the hospital itself might be beyond the necessity of being financed by income from its patients, and in order that the medical faculty might be free to pursue their work of investigation and instruction without recourse to personal practise.

In direct fulfilment of this hope and plan, the university board of trustees has just made one of the most important announcements in the history of the institution. The plan announced to be put into early operation provides for an undergraduate medical school, a graduate medical school and medical research. The first mentioned will be on the Midway Plaisance, in close connection with the science departments of the university. The standards of admission and of graduation will be as high as those of any medical school in the country. The number of students will be limited to such as can receive the best possible training with the facilities available.

A teaching hospital, duly equipped with necessary laboratories and lecture rooms, will provide for clinical instruction. Suitable endowments will free the hospital from the necessity of depending on paying patients, and the faculty from the necessity of practise for a livelihood.

The graduate medical school will be on the west side in connection with the work now done by the Rush Medical College and the Presbyterian Hospital. It will provide for medical graduates who wish further training and for practitioners who wish to keep in touch with progress in medical science. Research will be carried on in both places under arrangements to be announced later.

The plan involves an addition to the resources of the university of the sum of five million three hundred thousand dollars, one million for the hospital on the Midway, three hundred thousand for a laboratory on the west side and four millions for endowment.

Towards the endowment fund the Rockefeller Foundation offers one million dollars and the

General Education Board one million dollars, provided the entire sum of five million three hundred thousand dollars shall be raised. Further pledges of individuals have been made to the amount of seven hundred thousand dollars. Thus two million seven hundred thousand dollars have already been secured. Two million six hundred thousand dollars remain to be secured and in the near future a campaign will be initiated to complete the fund.

In speaking of this announcement, which is probably the most significant that has ever been made in connection with higher medical education in Chicago, President Harry Pratt Judson says: "The medical plans which have just been announced represent many years of hoping and working and dreaming. These plans, we think, will not merely be, when carried out, a great addition to the resources and power of the university, but will render a very valuable service to Chicago, and to the cause of medical teaching and investigation in the entire country."

A later announcement is just made that half a million dollars toward this new medical fund for the University of Chicago has been given by Mr. and Mrs. Julius Rosenwald, of Chicago. Mr. Rosenwald, who is a trustee of the university and donor of the new Julius Rosenwald Hall devoted to the work of geology and geography, is one of the university's most generous and loyal friends; and Mrs. Rosenwald, who shares in this great gift, is widely known for her practical and constant sympathy with many movements for social and artistic advancement in Chicago.

At the meeting of the board of trustees of the university on November 14, the following committee was named to conduct the campaign for funds: President Harry Pratt Judson, chairman; Adolphus C. Bartlett, Dr. Frank Billings, Thomas E. Donnelley, Andrew MacLeish, Martin A. Ryerson, Julius Rosenwald, Robert L. Scott and Harold H. Swift.

THE COUNCIL OF NATIONAL DEFENCE

PRESIDENT WILSON announced recently the appointment of the members of the advisory commission to be associated with the Council of National Defence created by congress at the last session. The seven men named are: Daniel Willard, president of the Baltimore and Ohio Railroad; Samuel Gompers, president of the American Federation of Labor; Dr. Franklin H. Martin, of Chicago; Howard E. Coffin, of Detroit; Bernard Baruch, of New York; Dr. Hollis Godfrey, of Philadelphia, and Julius Rosenwald, of Chicago.

A statement by the President in connection with the announcement follows:

The Council of National Defence has been created because the congress has realized that the country is best prepared for war when thoroughly prepared for peace. From an economic point of view there is now very little difference between the machinery required for commercial efficiency and that required for military purposes. In both cases the whole industrial mechanism must be organized in the most effective way.

Upon this conception of the national welfare the council is organized in the words of the act "for the creation of relations which will render possible in time of need the immediate concentration and utilization of the resources of the nation."

The organization of the council likewise opens up a new and direct channel of communication and cooperation between business and scientific men and all departments of the government, and it is hoped that it will in addition become a rallying point for civic bodies working for the national defence.

The council's chief functions are:

1. The coordination of all forms of transportation and the development of means of transportation to meet the military, industrial and commercial needs of the nation.

2. The extension of the industrial mobilization work of the committee on industrial preparedness of the naval consulting board. Complete information as to our present manufacturing and producing facilities adaptable to many-sided uses of modern warfare will be procured, analyzed and made use of.

One of the objects of the council will be to inform American manufacturers as to the part which they can and must play in national emergency. It is empowered to establish at once and maintain through subordinate bodies of specially qualified persons an auxiliary organization composed of men of the best creative and administrative capacity, capable of mobilizing to the utmost the resources of the country.

The personnel of the council's advisory members, appointed without regard to party, marks the entrance of the non-partisan engineer and professional man into American governmental affairs on a wider scale than ever before. It is responsive to the increased demand for and need of business organization in public matters and for the presence there of the best specialists in their respective fields.

In the present instance the time of some of the

members of the advisory board could not be purchased. They serve the government without remuneration, efficiency being their sole object and Americanism their only motive.

SCIENTIFIC NOTES AND NEWS

The University of Iowa at the last commencement bestowed the degree of doctor of laws upon Professor J. C. Arthur, emeritus professor of botany in Purdue University. In the presentation made by Mr. D. D. Murphy, president of the State Board of Education, the services of Dr. Arthur to pure and applied science were reviewed. Special emphasis was placed on his contributions to agriculture and horticulture in the study of plant diseases. This work began when, as the first botanist in an American experiment station, pear blight was investigated, and may be said to have culminated in the discovery of formaldehyde as a fungicide, especially for diseases of potatoes and grains. Studies on the relation of weeds to effective cultivation resulted in new methods for their control and extermination. His work in physiological botany, and his fundamental studies in mycology, have given occasion for the introduction of new technical terms, which have entered into general use. Other matters pertaining to the long and eminent services of Dr. Arthur were touched upon by President Macbride in conferring the degree.

Alumni of the department of geology and geography of the University of Chicago have presented to the university a portrait of Professor Rollin D. Salisbury, head of the department of geography and dean of the Ogden School of Science. The portrait, recently finished by Ralph Clarkson, the Chicago painter, is now at the Art Institute and will later have a permanent place in the new Julius Rosenwald Hall at the University of Chicago.

Professor M. Pasch, who holds the chair of mathematics at the University of Giessen, celebrated the fiftieth anniversary of his doctorate on August 21, 1915. On this occasion the University of Breslau renewed his diploma.

The Bakhuis Roozeboom medal has been awarded to Professor Schreinemakers, professor of inorganic and physical chemistry in the University of Leyden.

Dr. M. O. Forster, who was elected as a prospective Unionist candidate for parliament, has resigned. He is engaged in assisting the state-aided organization for producing dyes, work which absorbs all his time, and in the letter of resignation he says that the energy and resources of those occupied in the British dye industry must, if possible, be increased on the advent of peace.

We learn from *Nature* that the Chinese government has appointed as the head of a geological survey, Dr. J. G. Andersson, formerly chief of the Swedish Geological Survey, and with him already are Dr. Tegengren and Professor U. Nyström. Dr. T. G. Halle, assistant in the paleobotanical department of the Riksmuseum at Stockholm, is to travel in China for one year, mainly in the interests of his own department, for which he will collect paleozoic plants, but partly for the Chinese government, to which he will report on the age and character of the coal-seams inspected, and for which a duplicate series of fossils will be provided after their determination. A young Chinese geologist will accompany Dr. Halle, and will be trained by him as a paleobotanist.

Mr. Julius Lemkowitz, during the past year computer in the Yerkes Observatory, has gone to Princeton as observatory assistant.

Harvard University has granted a leave of absence for the second half of the academic year, 1916–17, to Professor W. C. Sabine, Hollis professor of mathematics and natural philosophy.

Mr. Roy Chapman Andrews, in charge of the American Museum's Asiatic zoological expedition, reports that nearly two hundred mammals and four hundred birds have been collected in the vicinity of Foochow, in the province of Fu-kien. Mr. Edmund Heller has joined the expedition, which on August 10 was on the way to Yunnanfu, to make collections in Yunnan Province.

Professor W. B. Scott, of Princeton University, gave an illustrated lecture on "The Relations of South America to other Conti-

nents, especially North America," in the geological lecture room of Harvard University on November 15.

The lecture course of the Washington University Association for 1916–17 opened this year with an illustrated lecture by Dr. H. M. Payne, of New York, formerly dean of the Missouri School of Mines and Metallurgy, on "The Gold Fields of Alaska and Siberia."

The Worcester Polytechnic Institute held a memorial service for the late Dr. Levi L. Conant, professor of mathematics, in Central Church, on November 19. The faculty and students attended in a body. The speakers were Hon. Charles G. Washburn, president of the board of trustees; Professor Z. W. Coombs, representing the faculty; Mr. C. H. Dwinnell, vice-president of the First National Bank of Boston, representing the alumni, and particularly the class of '94, with which Professor Conant began his work at the institute; and Dr. Homer P. Lewis, superintendent of the Worcester schools, representing the school board, of which Dr. Conant was a member for nine years.

The late Professor Clinton DeWitt Smith was the organizer and first director of the Agricultural College of Brazil, the first of its kind in that country. The present director writes that in token of grief for Professor Smith's death the college was closed for two days and the flag was draped in mourning and hoisted at half-mast.

We learn from *Nature* that Lord Rayleigh presided at the meeting held at University College, London, on October 31, to take steps to establish a memorial to the late Sir William Ramsay. Mr. J. A. Pease, M.P., postmaster-general, in moving that a memorial fund should be raised, to be utilized in promoting chemical teaching and research, under a scheme to be approved hereafter, said he was glad on behalf of the government to pay a tribute to the memory of Sir William Ramsay and to take part in the great object of the meeting. The memorial should be not merely national, but international. Sir J. J. Thomson seconded the motion, which was supported by the Belgian Minister, who wished to convey the respectful homage of Brussels University, and by Mr. W. H. Buckler, who testified to the interest of the American Ambassador and his countrymen in the movement. The resolution was carried. It was also agreed that the meeting should resolve itself into a general committee, with Lord Rayleigh as chairman, to raise the necessary fund, and an executive committee was appointed to circulate an appeal.

Dr. Percival Lowell, director of the Lowell Observatory at Flagstaff, Arizona, which he established in 1894, died of apoplexy on November 12, aged sixty-one years.

Dr. Walter S. Sutton, professor of surgery at the University of Kansas, died at his home in Kansas City, Kansas, on November 10. He was known to biologists for his service in pointing out the mechanism in the germ cells for Mendelian inheritance.

Charles Ellery Avery, at one time instructor in the Massachusetts Institute of Technology and later professor in the Massachusetts College of Pharmacy, known for his invention of the process of manufacturing lactic acid, has died, aged sixty-eight years.

Charles Francis Roper, to whom was due important inventions on automatic screws and in other directions, died on November 14, at the age of sixty-seven years.

S. B. MacLaren, professor of mathematics in University College, Reading, died on August 14, from wounds received in battle.

The death is also announced, at the age of fifty-two years, of Dr. David Maron, a Russian research chemist who had been resident in England for many years, as the result of an explosion in a munition factory in London, where he was carrying on experiments in the manufacture of high explosive shells.

Mr. M. W. Dominick has arranged to equip and endow the new medical library of the New York Medical College and Hospital for Women. Mr. Dominick offers this library as a memorial to his son, Dr. George Carleton Dominick, who recently died at sea. Dr. Dominick served the college for several years as lecturer and instructor.

A plan for the employment of the Sage Research Fund of the Medical College of Cornell University has been adopted. This fund of $50,000 was bequeathed to the university by Mrs. Sarah Manning Sage, widow of Dean Sage, for research in medicine. The plan adopted provides that a yearly appropriation from the income of the fund shall be administered by a committee composed of the president of the university and the heads of the departments that will participate in the fund; that a minimum be assigned by this committee each year to each of the departments; that a reservation be made for a specific research, and that each participant make an annual report. By action of the board there is an appropriation of $1,500 available for 1916–17.

The Lee Museum of Biology at Bowdoin College has been given a collection of Hawaiian ferns by John A. Cone, Topsham; a gift of shells and mounted birds by Mrs. John S. Towne, Brunswick, and the Rev. H. W. Winkley, Danvers, Mass., has added to his previous gift of New England shells. Leland C. Wyman has been appointed custodian of the collections of fossils and fishes.

At the invitation of the state geologist of Florida a conference of geologists and anthropologists was held at Vero, Florida, from October 23 to 30, the object of the meeting being to examine the locality near that place from which fossil human remains have been obtained. Those present at the conference were Dr. George Grant MacCurdy, Yale University; Dr. A. Hrdlička, U. S. National Museum; Dr. T. W. Vaughan, U. S. Geological Survey; Dr. O. P. Hay, Carnegie Institution; Dr. R. T. Chamberlin, University of Chicago; E. H. Sellards and H. Gunter, Florida Geological Survey; and I. M. Weills and Frank Ayers, of Vero.

We learn from the *Journal* of the American Medical Association that a South American Society for Microbiology, Pathology and Hygiene was organized at the National Medical Congress held at Buenos Aires in September. The new society is to publish a review at Rio de Janeiro and at Buenos Aires, in Spanish, Portuguese, French, English and German. The editorial staff consists of R. Krauss, director of the Bacteriologic Institute of Buenos Aires, and O. Cruz, director of the similar institution in southern Brazil and formerly chief health officer of Rio de Janeiro.

The magnetic survey vessel, *Carnegie*, left San Francisco, on November 1, on her homeward cruise of about 31,000 miles. She will make stops at Easter Island, Buenos Aires, Bahia, Porto Rico and return to Brooklyn in the fall of 1917. She has been gone on her long circumnavigation cruise since March, 1915, during which she has been in command of J. P. Ault of the Department of Terrestrial Magnetism.

The German Ophthalmologische Gesellschaft has divided between Lindner of Vienna and Ohm of Bottrop the von Graefe-von Welz prize for the best article published in 1911–1913 in the *Archiv für Ophthalmologie*. Their articles were on trachoma and inclusion blennorrhea, and on miner's nystagmus.

The *Observatory* remarks: "The sending of most kinds of printed matter from Britain to neutral countries (except by duly licensed publishers and booksellers) is now prohibited, and many astronomers must have wondered whether reprints of astronomical papers, reports of observatories, etc., which are usually posted privately, come under the ban. We have ascertained that these *may possibly* arrive at their destination, provided the full name and address of the sender is on the envelope; but they are liable (and quite likely) to be stopped. We may add that slip proofs sent for correction can be sent as usual. Also (for our foreign readers) that we duly receive scientific papers sent to this country from abroad."

Replying to a question raised in the British House of Commons, Mr. Forster stated that up to August 25, 1916, 1,501 cases were finally diagnosed as typhoid fever amongst the British troops in France, 903 amongst inoculated men and 508 amongst uninoculated men. There were 166 deaths, 47 of which were amongst the inoculated and 119 among uninoculated. To the same date there were 2,118 cases of paratyphoid fever, 1,968 amongst in-

oculated men, and 150 amongst men who had not been inoculated. There were 29 deaths—22 of which were amongst the inoculated and seven amongst the uninoculated.

THE Jesup lectures of the American Museum of Natural History are being given this year by Dr. R. S. Woodworth, of Columbia University, who has taken as his subject "Dynamic Psychology." The separate subjects and the dates of the lectures, which are on Friday evenings at 8:15, are as follows: November 10, The Modern Movement in Psychology; November 17, The Problems and Methods of Psychology; November 24, The Native Equipment of Man; December 1, Acquired or Learned Equipment; December 8, The Factor of Selection and Control; December 15, The Factor of Originality; December 22, Drive and Mechanism in Abnormal Behavior; December 29, Drive and Mechanism in Social Behavior.

DR. HERMAN M. ADLER, assistant professor of psychiatry, Harvard University, has commenced a study of the facilities for dealing with mental diseases and mental deficiency in Cook County, Illinois. The survey is under the general direction of the National Committee for Mental Hygiene and the expenses will be met by a special appropriation made by the Rockefeller Foundation. At the request of governors of the states, state boards of control, state boards of charities and social or civic organizations, the National Committee for Mental Hygiene has conducted or is at present undertaking such studies in Tennessee, Wisconsin, South Carolina, Louisiana, California, Connecticut, Georgia and Texas. The mayor and the board of estimate of New York City have seen growing up in their community a number of unorganized attempts to deal with what are apparently different phases of the same problem and within a few weeks a special committee has been appointed by the mayor consisting of the commissioner of accounts, the commissioner of public charities, the commissioner of corrections, the chairman of the parole board and the presiding justice of the children's court, to present a constructive plan for the examination, classification and proper treatment of mental defectives. The mayor's committee has requested the National Committee for Mental Hygiene to make for it such a survey as the study about to be commenced in Chicago. Thus studies of the same subject will be carried on simultaneously under the same general direction in the two largest cities of the country.

THE annual meeting of the American Social Hygiene Association and joint conference with the St. Louis Social Hygiene Society and Committee of One Hundred of St. Louis was held in St. Louis, November 19 to 21. The chief subjects for discussion were "The New Public Conscience," "Health Aspects of Social Hygiene," "Ways and Means of Public Education regarding Social Hygiene" and "Repression of Commercialized Vice."

THE orthopedic department of the Children's Hospital, Boston, will offer a course, beginning on December 1, 1916, in muscle training and in the principles of the nursing aftercare of infantile paralysis. This course will be open to a limited number of properly qualified women and will be an all-day course covering a period of about six weeks, most of the work being in the clinics and practical in character. The course will be under the general supervision but not under the actual instruction of Dr. R. W. Lovett, surgeon to the hospital to whom application for admission should be made.

THE Peabody Museum of Harvard University has received from Arthur Bowditch, Jr., '03, a large collection of spears, household articles and wearing apparel of the Bagoba, Manoba, Moro and other tribes of the Philippine Islands. The collection was made by him in 1914.

THE botanical collections of Mr. S. B. Parish, comprising over 50,000 herbarium sheets, have been purchased by Stanford University. Mr. Parish has devoted about forty years to the flora of southern California, and his herbarium contains the most complete collection of plants from that region that has been brought together.

Stanford University, with the cooperation of Dr. N. L. Britton, director of the New York Botanical Garden, has arranged to finance the publication of an Illustrated Flora of the Pacific Coast. Dr. LeRoy Abrams will edit the work, with the assistance of a number of the leading American botanists as collaborators. The flora will comprise four volumes containing illustrations and descriptions of every species of ferns and flowering plants on the Pacific coast.

At a meeting of the council of the National Museum of Wales, held at Cardiff, on October 28, it was announced, according to *Nature*, that a sum of £10,000 had been received from Capt. W. R. Smith, senior partner of the firm of W. R. Smith and Son, Cardiff, and Mrs. Smith, towards the building fund of the new museum. The donors had made this gift in the belief that the National Museum would be one of the first educational influences in the principality. There were other donors, who wished to remain anonymous for the present, and it is expected that when the present contract has been paid there will be a balance of about £16,000 towards the £50,000 which is needed to complete the furnishing and equipment of the portion of the building at present in course of erection.

The Embar formation of Wyoming is known chiefly for its extensive phosphate beds, which are supposed to have been derived in some manner from animal remains. The rocks contain abundant fossils, many of which are phosphatic, and all of which prove that the Embar beds of western Wyoming were deposited in the sea. Recent study of the eastward extension of the Embar formation in Wyoming shows that along the east margin of this ancient sea, or throughout the Bighorn Mountain region, the climate was probably more arid than that of any part of Wyoming to-day. By long evaporation beds of gypsum were deposited at some places in arms of this sea to a thickness as great as 100 feet. It is a question of practical importance whether beds of salt, and perhaps of potash salt, may also have been deposited in this formation and whether they may now be found below the surface. The United States Geological Survey, Department of the Interior, urges that oil men, in drilling through the Chugwater and Embar red beds in Wyoming collect samples of drillings and of brines and submit them to the survey for examination as to their possible potash content.

UNIVERSITY AND EDUCATIONAL NEWS

At the meeting of the trustees of the Carnegie Foundation for the Advancement of Teaching, held in New York on November 15, the proposal to make the pension system contributory was considered and action was postponed. This was the recommendation of the committee of the American Association of University Professors which was represented at the meeting of the trustees by Professor Edwin R. A. Seligman, vice-president of the association, and Dean Harlan F. Stone, chairman of the committee that drew up the report on the subject. The proposed plan of contributory pensions was referred to a committee composed of Dr. Henry S. Pritchett, president of the foundation; Dr. W. F. Slocum, president of Colorado College, chairman of the board; Sir William Peterson, president of McGill University; President Charles R. Van Hise, of the University of Wisconsin; President A. Lawrence Lowell, of Harvard University, and Chancellor T. B. McCormick, of the University of Pittsburgh, representing the foundation, and five representatives from the American Association of University Professors, the Association of American Universities, the National Association of State Universities and the Association of American Colleges.

The chemistry building at the State College of Agriculture and Mechanic Arts of the University of Montana, Bozeman, was completely destroyed by fire on October 20. This building furnished quarters for the college and experiment station departments of chemistry, the state food and water laboratory and the departments of physics and geology. The fire occurred in the day time and all department's records, the chemical library and the materials in the chemical and geological museums were

saved together with part of the apparatus. Chancellor Elliott has announced that a new chemistry building will be erected as soon as possible.

FINAL plans have been drawn for a head house for the school of applied science of the Carnegie Institute of Technology, which is to cost $300,000. A portion of the building will be four stories high and the remainder ten. Construction work will start as soon as steel deliveries can be made. The structure will house the executive offices and library of the engineering school, and the departments of modern languages, machine design and commercial engineering.

DR. H. E. EGGERS has been appointed professor of pathology and bacteriology, Dr. Amos W. Peters, assistant professor of biochemistry, and Dr. John T. Myers, instructor in bacteriology, in the college of medicine of the University of Nebraska, Omaha.

PROFESSOR J. VERSLUYS, who has held the chair of zoology and comparative anatomy at Giessen since 1907, has been appointed to the corresponding chair in the new Flemish University at Genth.

THE *Journal* of the American Medical Association indicates that negotiations are pending that may bring Professor R. Bárany, of Vienna, to the University of Stockholm as professor of otology and rhinolaryngology. He recently delivered at Stockholm the customary address describing his research when presented with the Nobel prize. It will be remembered that he was a war prisoner in Russia when notified that the prize in medicine had been conferred on him.

DISCUSSION AND CORRESPONDENCE

CAN A BODY EXERT A FORCE UPON ITSELF?

IN connection with our annual attempt to give our students a few clear ideas about elementary dynamics, the question of the meaning to be assigned to the word *force* perennially arises. May I call attention to a well-known phenemenon which seems well suited to serve as a shibboleth in distinguishing between clear and hazy conceptions of force?

Let a liquid be uniformly rotated in an open vessel. What are the forces acting on each surface particle? Why is the free surface parabolic?

In answering these questions one recent author finds it necessary unwittingly to deny all three of the laws of motion. He states that "When a liquid is at rest or in equilibrium *the resultant of all the forces acting on a particle in its free surface is perpendicular to the surface at that point*" [whereas according to the first law the resultant force must be zero]. In the case of a rotating liquid, we are told, "the resultant force acting on the surface particles is due not only to gravity, but to centrifugal force. . . . It will be noted that the resultant force [shown drawn perpendicular to the free surface] is greater at points higher up on the surface, so that a surface particle near the top presses against the surrounding liquid with far more force than it would if at the bottom of the curve." But according to the second law the resultant force must be in the direction of the resultant acceleration, which in this case is obviously centripetal; and according to the third law, if the particle presses against the surrounding liquid, the liquid must press back upon it with an equal and opposite force not mentioned by the author.

Such an explanation is evidently completely misleading. Yet another recent text-book does equal violence to the laws of motion in explaining the same phenomenon. "The resultant force," we are told, "is made up of two components; one of these is the weight of the particle, mg, the other is the reaction which the particle offers against acceleration toward the center by the centripetal force $mr\omega^2$."

Of course the trouble is that among mathematical physicists it has been customary to reduce such problems to purely statical ones by introducing centrifugal forces in accordance with D'Alembert's principle; but authors of elementary texts sometimes forget that the forces so introduced are purely imaginary.

Does not the third law mean this: A body A can not exert a force upon itself as a whole; any force acting on it must be due to, that is, associated with, the existence of, some

other body or medium B; and that other body or medium B while exerting a force on A, is experiencing an equal and opposite force due to A; whenever the existence of a force on A is discovered we should immediately seek out the body or medium B which is the other party to the transaction; whenever a force is mentioned, the body or medium exerting the force should be clearly in mind.

Considered from this point of view, the answers to the above questions regarding a rotating liquid would run somewhat as follows: The forces acting on a water particle in the free surface are (1) its weight, *due to* the earth, (2) a force *due to* the liquid in contact with it, and (3) a force normal to the surface, *due to* the atmosphere. The resultant of these is a centripetal force since the acceleration is centripetal. If we can prove that the second force is normal to the free surface, then it follows immediately from the force triangle that the normal to the surface makes an angle with the axis of spin whose tangent is equal to the ratio of $r\omega^2$ to g, and that the section of the free surface is parabolic.

The proof we need is the following: Suppose a closed, cylindrical can, full of liquid and with its bottom horizontal, is uniformly rotating around the vertical axis of symmetry. On any co-axial cylindrical surface within the liquid with a radius r there is a pressure because of the rotation equal to $\frac{1}{2}\rho r^2\omega^2$ per cm.^{2}; at any height y above the bottom there is also a hydrostatic pressure due to gravity equal to $P - \rho gy$. The equation for a surface of constant pressure within the liquid is therefore

$$\tfrac{1}{2}\rho r^2\omega^2 + P - \rho gy = \text{constant},$$

$$r^2\omega^2 - 2gy = \text{constant}.$$

But the force on any particle due to the surrounding liquid is, of course, normal to the surface of constant pressure at that point. If we now suppose the can opened on top and all the liquid within a surface of constant pressure removed, the pressure formerly exerted by the removed liquid would be supplied by the atmosphere and the remaining liquid would continue to rotate exactly as before. Thus the free surface of our rotating liquid must coincide with a surface of constant pressure, and the force on a surface particle due to the liquid in contact with it (including surface tension), being normal to the surface of constant pressure, is normal to the free surface. In a similar manner the more general proposition may be proved that the free surface of any liquid whose particles remain at a constant distance from each other during any motion, is *normal to the force with which the liquid acts on the surface particles at each point,* and is not, as often stated, normal to the resultant force acting on them.

When a student finds in an elementary text the statement that "when a body *is* accelerated we may consider the force of reaction as one of the forces acting upon the body," and is told that one of the forces acting on one of the masses of an Atwood's machine, m_1, is "the reaction of the mass m_1 against its upward acceleration" [which is equivalent to the statement that a body when accelerated acts upon itself with a force ma, so that the resultant force is always zero]—when a student tries to reconcile such assertions with the laws of motion, is it surprising that he becomes confused and discouraged?

Why not use force only in the single definite sense implied in the laws of motion?

The fact that the two authors quoted are unusually experienced and successful teachers suggests that they are not the only ones who are making the path of freshmen unnecessarily difficult. I have taken the liberty of using them as "horrible examples" in this respect because their text-books are for the most part admirably clear, and because I know them to be men who are big enough not to resent well-meant criticism.

If there is any question as to the wisdom of the conclusion suggested above, let us thrash the matter out now. To avoid misunderstanding, let me add that in using the phrase "force due to—" for the sake of brevity, no relation of cause and effect is implied in any critical philosophical sense.

GORDON S. FULCHER
UNIVERSITY OF WISCONSIN,
November 3, 1916

LATERAL VISION AND ORIENTATION

TO THE EDITOR OF SCIENCE: Professor C. C. Trowbridge furnished an illuminating paper, printed in SCIENCE September 29, on "The Importance of Lateral Vision in its Relation to Orientation."

In dealing with the question of the process used by man, with his binocular frontal vision, in estimating distances to objects that come within his observation, Professor Trowbridge says:

> It is a well-established principle that binocular vision gives to human beings a means of determining the relative distances between near-by objects, as well as the distances of these objects from the observer. The basis of this power lies in seeing the objects from two points of view, giving a stereoscopic effect, which, however, is decreasingly effective as the objects are removed from the eyes. It is apparently partly the decreasing stereoscopic effect with increasing distance which forms the basis of measurement, and partly a judgment of distance in some way through the muscular movements of the eyes, and those governing the accommodation of the lenses. . . .

From the above quotation it appears to the writer that Professor Trowbridge has missed the fundamental principle of estimating distances to observed objects by human binocular vision. If the writer's view or theory is correct, when a man estimates such distances by his vision, he unconsciously performs a trigonometrical operation, in which the distance between the pupils of the eyes is the base of a triangle, the two lines of vision from the pupils, converging in the observed object, being the other sides of the triangle.

The same principle is used by the "range-finder" on a ship of war, who has a rod about ten feet long as the base of his triangle, from each end of which is measured the angular inclination of the two lines converging in the target, five or ten miles distant. The "binocular" observer has a base two and a half or three inches long, for objects a few hundred feet distant and less. The range-finder makes accurate calculations based on measurements; while the "binocular" observer, from long practise, acquires a sort of "rule of thumb" facility in making such estimates with more or less approximate accuracy, which operation from long habit is performed intuitively and without conscious mental effort.

A man with only one eye, or with defective vision in one of his eyes, finds a difficulty in estimating the correct distance to an object which he extends his hand to grasp; or when inserting a key in a keyhole he must sometimes aid his vision by the touch of a finger to locate the keyhole.

It follows of course that a man with only one eye is without the power to invoke the principle of trigonometry in the estimating of distances to observed objects.

If the above theory is unsound the writer will be glad to have further enlightenment on the question discussed.

T. G. DABNEY

A COMMON, BUT INCORRECT, STATEMENT CONCERNING THE NUMBER OF BACTERIA IN MILK

THE literature discussing sanitary milk problems is full of statements like this: "Certified milk is not allowed to have more than 10,000 *bacteria per c.c.*"; or "Grade A milk should not have over 60,000 *bacteria per c.c.*"; and many other similar statements specifying the *number of bacteria per c.c.* in milk of various grades. These counts are commonly made by the standard agar plate method recommended by the American Public Health Association.

A perusal of a number of bacteriological text-books by American authors shows a general recognition of the fact that these counts are probably counts of groups of bacteria rather than of individual bacteria and that they are probably always lower than they should be because of the fact that not all bacteria will grow on nutrient agar at the incubation temperature used. In spite of these qualifications specifically stated in the majority of these text-books, their authors ignore them in all subsequent discussions and accept agar plate counts as showing the *number of bacteria per c.c.* Occasionally in these books or elsewhere in bacteriological literature, one even finds the bald assertion that each colony

on an agar plate develops from a single bacterium.

The development of microscopical methods of counting bacteria in milk have now made it possible to check up this matter. Studies at the N. Y. Agricultural Experiment Station by J. D. Brew, as well as cooperative analyses carried out by the dairy husbandry department of the N. Y. State College of Agriculture at Ithaca and the bacteriological department of the Agricultural Experiment Station at Geneva have shown that the number of bacteria in market milk is rarely less than twice the number of colonies developing on agar plates even after prolonged incubation at two different temperatures; and that the number of bacteria is usually from three to six times the number of colonies. In those fairly common market milk samples where the predominant bacterial flora consist of long chain streptococci, the actual number of bacteria present may be fifteen to twenty-five times the number of colonies on agar plates.

With these facts established, there seems to be no justification for continuing the present unscientific custom of referring to agar-plate counts as showing the number of bacteria in milk. As a matter of fact they show the number of colonies developing on nutrient agar (or other culture medium) under the conditions of incubation used, and nothing more. In the earlier literature the latter form of expression was common and is still used by some investigators. Americans, however, generally use the inaccurate form of expression especially when discussing sanitary milk problems.

It does not require a vivid imagination to picture the dismay of the layman, whether consumer, milk dealer or farmer, when he discovers that what he has been told about the number of bacteria in milk is all based on a fallacy and that the real numbers are from one and a half to twenty-five or more times the figures which have been given to him. Neither does it require a vivid imagination to predict that those forces which find it to their advantage to resist the efforts which are being made to control our milk supplies will be quick to seize upon the seeming inconsistencies of bacteriologists as a means of discrediting the use of bacterial counts for controlling milk supplies.

So long as there was no available method by which the actual number of bacteria in milk could be counted, the use of the short form of expression had some excuse because of its convenience. Now that the real facts are known, its continued use will increase the present confusion. This confusion does not trouble bacteriologists, nor will it do so, for the majority of them have understood all of the time that they were probably not telling the truth about the matter; but it does bewilder the uninitiated.

Robert S. Breed
N. Y. Agricultural Experiment Station

OSTWALD'S HANDBOOK OF COLLOIDAL CHEMISTRY

In a criticism[1] of my review[2] of Professor Fisher's translation of Wo. Ostwald's "Handbook of Colloidal Chemistry" Professor Richard C. Tolman disagrees with my statements concerning negative surface tension, and submits certain thermodynamic considerations and experiments as evidence of the existence of negative surface tension. The question is one over which two people may disagree inasmuch as it depends solely on their point of view. Professor Tolman relies principally upon thermodynamic considerations, while I refuse to consider energetics as infallible in the present case, but base my reasoning on ordinary atomistics. In fact I regard the application of thermodynamics to disperse systems as decidedly hazardous.

In the first place it is well known (Maxwell) (Smoluchowski) that the second law is no longer valid when applied to particles approaching molecular dimensions. Secondly the first characteristic of all colloidal solutions is *unstability*. I have yet to experience an absolutely stable permanent colloidal solution. Once we admit the absence of true thermo-

[1] Science, 44, 565, 1916.
[2] Science, 43, 747, 1916.

dynamic equilibrium Professor Tolman's reasoning loses its validity. What is our criterion of stability? Colloidal gold solutions prepared by the reduction of dilute gold chloride solutions with phosphorus are looked upon as being exceedingly stable, in fact they appear almost optically homogeneous under the ultra microscope; yet those prepared by Faraday by this method are still preserved at the Royal Institution—long since coagulated. And of course the rate of change (viscosity) of the hydrophyllic sols mentioned by Professor Tolman is measured in hours and minutes, *i. e.*, they are to be regarded as anything but stabile in the thermodynamic sense. Are we not to consider this question of time at all? Are we to abandon our hope of a kinetic explanation of the change of size of particles when under the ultra microscope we can observe the clumping together of particles and the cessation of the Brownian movement?

As experimental evidence of negative surface tension Professor Tolman cites the gel-sol change of a number of reversible colloids. Perhaps there is an increase of surface in such changes, but our knowledge of the internal surface of gels of gelatine, agar-agar, ferric hydroxide, etc., is, at best, somewhat limited. It can, however, be experimentally shown, from vapor pressure studies of these same gels, that the internal surface is enormous.[3] Furthermore if the internal surface of the gel is decreased (dehydration) the gel-sol change in many cases does not take place. It is therefore an open question as to just what increase of surface occurs in the gel-sol change.

But Professor Tolman should not limit himself to the gel-sol change as experimental evidence of negative surface tension; as a matter of fact he is forced to extend it to include the solution of all substances. For in the process of solution we surely have an enormous increase of surface, consequently an exhibition of negative surface tension. This leads at once to a general theory of solution. Here we meet an old idea that one frequently comes across in scientific literature, but which has never been seriously considered because it represented no real progress.

[3] I have calculated that the internal surface of one gram of silic acid gel is approximately 2,000,000 cm^2.

The fundamental concept of surface tension is molecular attraction, and until we can experimentally show repulsion between molecules *without the addition of external energy*, we must regard negative surface tension as a mathematical quantity to which not much meaning may be attached. In other words, until we can obtain a substance which spontaneously increases its surface (wrinkles and folds), and we must here clearly separate phenomena of solution, vaporization and osmose, we have not much right to speak of negative surface tension.

Professor Tolman quotes Professor F. G. Donnan as a possible exponent of negative surface tension. I can say from a year's association with Professor Donnan that he has long since recognized the futility of ordinary energetics in giving a solution to the perplexing and intricate problems of disperse systems. Is it not better, in view of the multitude of factors involved, to push our experimental study of these systems a bit further, before we burden ourselves with an intricate systematic of doubtful validity? The lines of attack laid out by Freundlich, Zsigmondy, Svedberg and van Weimarn are infinitely more hopeful.

W. A. Patrick

Syracuse University

THE RELATION OF OSMOTIC PRESSURE AND IMBIBITION IN LIVING CELLS

In No. 1115 of this journal Jacques Loeb[1] publishes some ideas regarding the above, which he himself considers "so self-evident that their publication would seem superfluous were it not for the fact that Wolfgang Ostwald and other colloid chemists deny the existence of semi-permeable membranes in the muscle on account of the fact that acid causes proteins to undergo imbibition." Since this article by Jacques Loeb is, therefore, published chiefly for my benefit, I beg to point out the following:

Never, and in none of my publications, have I said anything of this kind. I have never

[1] Jacques Loeb, Science, 43, 688 (1916).

denied the "*existence*" of semi-permeable membranes in muscle nor have I ever discussed them in any publication. Neither have I denied the existence of such membranes, *because* proteins swell more in acids than in water. In fact, I see no cogent reason for even thinking of these two things as at all related to each other, wherefore the conclusion attributed to me by J. Loeb becomes entirely unintelligible, and appears, as a matter of fact, absolutely absurd. It is true that I have, at various times, lectured on the "*rôle*" of semipermeable membrane in muscle, and, with many other physiologists and colloid-chemists, have come to the conclusion that these membranes play a much smaller part in the problem of water absorption than many physiologists formerly thought and J. Loeb still thinks. I still regard the rôle of osmotic processes in the problem of water absorption by muscle as only of secondary importance, yet even in my latest publication[2] I state that "I do not wish to uphold the somewhat extreme view that osmotic changes play no rôle whatsoever in the problem of water absorption by organisms." I know full well, moreover, that this position is regarded as too conservative by some of my colloid-chemical colleagues and as inadequate in the light of the newer developments of our knowledge.

These facts make it evident that J. Loeb is absolutely wrong in his statement that I have denied the existence of semi-permeable membranes in muscle, and still more wrong when he says that I have done this "on account of the fact that acid causes proteins to undergo imbibition." So far as *my* published thoughts regarding this question go, the statements in the article of J. Loeb appear, as a matter of fact, not only, as he says, "superfluous," but wrong and misleading. The whole argument of J. Loeb is based upon an entirely arbitrary distortion of my views.

Wolfgang Ostwald

University of Leipzig,
August 5, 1916

[2] Wolfgang Ostwald, "Die Welt der vernachlässigten Dimensionen," 133. Dresden and Leipzig, 1915.

SCIENTIFIC BOOKS

Weather Forecasting in the United States. By a Board consisting of Alfred J. Henry, Edward H. Bowie, Henry J. Cox, Harry C. Frankenfield. Washington, 1916, Weather Bureau, No. 583. C. F. Marvin, Chief. Pp. 370, 119 charts.

This volume of meteorological studies is timely in its appearance and creditable as to its contents. Time and again the question has been raised as to whether weather forecasting is entirely empirical or based on scientific principles within ordinary comprehension. Almost synonymously with these memoirs appeared the bulletins of the Carother's Observatory, Houston, Texas, on the correlation of solar and weather phenomena, with which system of long-time weather predictions Professor Willis Moore, former chief of the Weather Bureau, is associated. This observatory announces the issue, for each state, of long-time forecasts ranging from eleven to eighteen days in advance. These forecasts are based on variations in the solar radiation received by the earth, which are said to cause rotating cyclonic eddies in recurring periods of eighteen days. The Carother's method of forecasting is only one of several systems advanced by individual scientists in the United States, which seek public recognition as to the value of their theories and as to the accuracy of their weather predictions.

At times the U. S. Weather Bureau has issued forecasts for even a week in advance. It has remained for the Argentina service, beginning in 1915 under Professor Wiggins, to regularly issue forecasts for a week, indicating the temperatures for 8 A.M. and 8 P.M., as also the days on which rain is expected.

Since Professor Marvin, the chief of the Weather Bureau, has officially stated that systems of the Carothers and allied types are fallacious, it is of special importance that the general public should be definitely informed as to groundwork of the national weather forecasting. This system has been developed during the past forty-six years under the control and direction of Generals A. J. Myer, W. B.

Hazen, A. W. Greely, followed by Professors H. W. Harrington, Willis Moore and Charles F. Marvin. The theoretical evolution has been principally accomplished by a civilian staff, among whom may be mentioned Ferrel, Abbe, Maury and Humphreys, and the practical work by officers of the army, by observers and professors. The present force has risen from the lower grades through successful work of a quarter of a century or more to commanding positions.

This review does not discuss the relative merits of the various systems, official and non-official, but seeks to summarize with brief comments the accuracy or fulness of the official national methods herein presented, concerning which the public is not generally informed.

The reviewer prefaces his comments by stating that notwithstanding his open mind to scientific discoveries in meteorology, yet his views on long-time forecasts were formulated and published more than a quarter of a century since, in *American Weather*, N. Y., 1888. In this publication, the first American work wherein definite rules for forecasting were advanced, after quoting Blanford as to droughts and temperatures, the present writer found the sun-spot theory fallacious as to rainfall in the United States, but added:

> The advances of meteorology are insufficient to justify predictions of the weather for a season in advance. There are apparently good grounds for believing that general laws can be deduced by which, from abnormal distributions of atmospheric pressure, to predict for prolonged periods in advance the general character of the coming season, as warm or cold, and wet or dry.

Almost without exception the authors of the various memoirs in weather forecasting have had practical experience in meteorological work with the Weather Bureau for thirty years, and so speak with a degree of authority that makes their opinions worthy of careful consideration.

The first essay, modestly styled Introductory Note, by Professor C. F. Marvin, sets forth clearly and succinctly the theory of atmospheric circulation, the essential basis of the science of forecasting. His action in promptly initiating these investigations, in 1913, gives promise of further memoirs as later studies add to meteorological knowledge.

Professor W. J. Humphreys has brought together a comprehensive summary of existing knowledge as to winds, cyclones and anti-cyclones. He advances reasons as to why the average velocity of winds steadily increases to 600 meters' elevation, decreases to 1,000 meters, and after fluctuations steadily increases from 2,000 meters upward. In this connection he believes that:

> The horizontal pressure gradient maintained by the temperature difference between adjacent regions is approximately constant with a tendency towards a maximum gradient at about 8 kilometers roughly.

In connection with the origin of cyclones and anti-cyclones Humphreys considers the various hypotheses: Ferrel's convectional, Hann's driven-eddy—both discussed by Professor Davis—and Mitham's counter-current. He believes that none of these theories contains clear and workable conceptions of "the origin, mechanism or maintenance of the extra-tropical cyclones," but that they "still remain the meteorological mysteries they have always been." He points out that tornadoes, "well-nigh peculiar to the United States east of the Rocky Mountains," develop usually in the southeast quadrant of a low-pressure area, the tornado being "a vigorous convection between strong neighboring counter-currents." He indicates the presence of permanent and semi-permanent low areas.

It is to be regretted that he did not consider in this connection the normal transfer to and from various regions, in the northern hemisphere of pressures from month to month, which, deduced largely from the international series of simultaneous observations, were charted and briefly described by the writer twenty-six years ago.

Coming to the practical problems, Professor A. H. Henry treats the subject under the head of weather forecasting, pressure changes, highs and lows, and forecasts in the Washing-

ton district. He outlines clearly the synoptic chart method, the basis of all American weather forecasts. The general control of the weather through atmospheric changes of pressure are shown, with their general course from west to east. Illustrating typical lows by charts, he indicates seven separate types: circular, secondary, V-depressions, cols or saddles, anti-cyclone, wedge-shaped and straight isobars. The result of such typical formations are discussed quite fully.

Speaking of the maps of temperature and pressure changes, the two most valuable charts in forecasting, an error is committed in speaking of them as made thrice daily. The writer reduced the observations from tri-daily to semi-daily about thirty years since—a great reduction in expense, much criticized at the time, but which did not reduce the efficiency of the service.

While the associations of high temperatures with low pressures, and of low temperatures with high pressures are noted, yet Henry frankly admits that allobars—the technical term for areas of pressure changes—remain a mystery. Forecasts from katallobars, areas of falling pressure, are considered under the headings: changes in form, greatest fall at center in twelve hours, and concentration of fall. While allobars are perfected in twelve hours in Canada, the time increases southward to thirty-six hours in the Gulf States. The memoir on highs and lows is quite complete. Henry points out that "the movement of lows seems to coincide with the seasonal direction of the planetary winds, of which they are doubtless a part," and states that the "speed of lows varies directly with the strength of the general winds." As to precipitation, in addition to other comments, he considers that "when the high is north or northeast of the low, the tendency to unsettled weather and precipitation in the regions between them is at a maximum." The lows are considered by groups, according to their primary appearance, as follows: North Pacific, South Pacific, Alberta, Northern Rocky Mountain, and Colorado, Texas, East Gulf, South Atlantic. Highs are similarly treated.

Forecasting in the Washington district, by Henry, contains treatment of seasonal influences. He gives for Ohio five rules for warmer weather, and six for colder weather. It would have been most valuable if he had added similar rules for other states. As to the prolonged heated terms in the middle Western States Henry says:

> They are probably due to fundamental causes in the general circulation, the nature of which we do not know.

They end with the disintegration of a southeastern high and the formation of a northwestern high.

Cold-wave forecasts are fully treated by Professor H. J. Cox, who finds the pressure-change charts far the most important element therefor. Cold waves usually occur through the rapid advance, with steep barometric gradients, of highs in rear of well-marked lows. Cox describes the various types of cold-waves, and sets forth the effect thereon by topography, especially by the Great Lakes and by the proximity of the ocean. Well-selected charts illustrate the formation and advance of such waves. He points out that atmospheric conditions for vast distances, even over an area of 4,000 sq. miles, are potent factors, through temperature, pressure, humidity, pressure gradients, cloudiness and snow-covered areas.

Supplementary to cold waves Cox discusses frost warnings, indicating the modifying influences of topography, especially in the shape of large bodies of water, moist soils and drained land. He also dwells on the different effects of fast and of low moving highs, the latter often producing frosts for successive nights. Dew-point readings in the evening are considered fallacious indications as to frosts, while humidity percentages have influences not clearly understood as yet.

Local peculiarities as to cold waves and frost-warnings, of much value and interest, are presented by Forecasters John W. Smith, of New England, L. M. Cline for the West Gulf, F. H. Brandenburg for Denver, E. A. Bealls for the North Pacific and G. H. Willson for the South Pacific. These experienced fore-

casters also present valuable data and opinions as to weather and temperature forecasts in their respective districts.

The subject of high winds is efficiently treated by Forecaster E. H. Bowie, who indicates the various types of pressure from which they occur. While pressure gradients induce high winds of definite relative force, yet exceptions to the rule are noted. Hurricanes, northers and blizzards receive due consideration. He mentions the intensity of action caused by twelve different types of lows. Special supplementary treatment of the storm winds of the Atlantic and Gulf coasts is presented by Professor H. C. Frankenfield, and similar data for the North Pacific coast by Forecaster Bealls, for the South Pacific coast by Forecaster Willson, and for the Great Lakes by Professor Cox.

Professor H. C. Frankenfield discusses the forecasting of snow, of sleet and ice storms, dwelling especially on their seasonal and geographic distribution. He indicates seven distinct conditions precedent to sleet and ice storms, and five necessary conditions preceding fog formation. Similar treatment of thunderstorms comes from Professor Henry.

Forecaster Bowie in discussing long-range weather forecasts considers seasonal forecasts as improbable even in the near future. He indicates, however, sixteen types of pressure conditions in various regions of the northern hemisphere which enable meteorologists to forecast conditions, elsewhere consequent, from two days to two weeks in advance.

The bibliography and index are unsatisfactory, and most annoying to any student. There are about a score of publications referred to in the text which do not appear in the bibliography, while titles of small import are given place. This is a small matter, but it mars the publication.

As a whole, while these memoirs will be indispensable to every forecaster and experienced meteorologist, as far as the public is concerned they will be valuable only to advanced students of the science. They are quite beyond the scope indicated by Chief Marvin as a text-book or manual suitable for the guidance and instruction of beginners. It is to be hoped that in due time there will appear a series of local manuals—not more than 24 pages in length—wherein should be presented such simple rules as would enable business men to still further utilize the daily weather map. The writer had a similar intent when he incorporated in *American Weather* twelve rules for general use in weather forecasting, which the board of professors has generously recognized in their preface. Doubtless a hundred similar rules—simpler and better—could be deduced by the experienced professors who have prepared these memoirs, whose value to students is recognized as of the highest order.

A. W. GREELY

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SPECIAL ARTICLES

THE RESULTS OF EXTIRPATION OF THE ANTERIOR LOBE OF THE HYPOPHYSIS AND OF THE THYROID OF RANA PIPIENS LARVÆ

THE writer has long been impressed with the desirability of testing the effects of extirpation of the glands of internal secretion at the very beginning of their development in order to determine the part that they play in the development and differentiation of the embryo. Of all the vertebrates the anurans seemed to offer the greatest opportunities for such work. Adler ('14)[1] performed experiments of this kind, but the operation was carried out at a late stage and consequently did not entirely exclude the early influence of the gland. Early in the spring of 1915 the writer removed the anlage of the anterior lobe of the hypophysis at the time of closure of the medullary folds by removing the surface ectoderm from which it would shortly afterwards develop. This attempt resulted in a large degree of mortality and was abandoned. This spring the operation was successfully accomplished by making a transverse frontal cut extending back the entire length of the fore brain and parallel to it a sufficient distance below to just expose the ventral surface of the hy-

[1] Adler, L., "Metamorphosestudien an Betrachierlarven. I. Extirpation endokriner Drüsen. A. Extirpation der Hypophyse." *Arch. f. Entwickelungsmech. d. Organ.*, Bd. 39, 1914.

pophysis ingrowth. When this is performed at the stage of from 3.5–4 mm. total body length the hypophysis anlage can be readily seen and removed. The wound heals in from 20 to 30 minutes and the tadpoles quickly recover. In the course of these experiments the anlage was successfully removed from 430 tadpoles.

This phase of my work was duplicated by Dr. P. E. Smith,[2] who published a preliminary account of his work in the August 25, 1916, number of SCIENCE. During the month of July prior to this time I had the pleasure of discussing my work with Dr. Smith at Berkeley. Previous to this time I had no knowledge of his work nor of his plans and he assures me that he was equally ignorant of my work. We both presented papers upon our experiments at the meeting of the Western Society of Naturalists at San Diego, August 9 to 12. On the 7th of June, before starting west, I demonstrated specimens and explained my results to a number of scientists, including Professor Frank R. Lillie, Dr. Emil Goetsch, Dr. Chas. H. Swift and a number of others whom I met in Chicago at that time. It is thus clear that these experiments were independently conceived by Dr. Smith and myself and that we worked contemporaneously upon them each without knowledge of the other's work until July, 1916, two months after the experiments had been performed. It was impossible to give an earlier report upon this work because the experiments upon thyroid removal required a long period of time to establish definite results.

Our results are in accord in showing that the removal of this gland has an early effect in producing a great contraction of the superficial pigment cells. The results in my specimens were very striking. I found that my tadpoles assumed a uniform creamy silver color. This change was evident on the seventh to eighth day after the operation. Our work is further in accord in that we both observed a retardation in growth very marked in my material and a striking retardation in the development of limbs. The buds appeared but remained very small. One specimen kept alive until August 30 had only reached a length of 30 mm. and the limb buds were still extremely small after the controls had all fully metamorphosed into frogs. Through all this time it maintained its silvery color.

Dr. Smith found that there was no more mortality among his operated tadpoles than among the controls. This is quite contrary to my experience; but is no doubt explainable upon the grounds that he had a more favorable water supply than ours. In my experiments upon removal of the hypophysis there was a very heavy mortality. I am convinced that this must be explained upon the ground that the presence of the hypophysis anlage is necessary for the proper adjustment of the tadpoles to these injurious influences. It might be mentioned at the outset that in roughly one third of the operated tadpoles the upper part of the mouth was defective. This was due to the removal or disturbance of its anlage in the operation. These tadpoles were of course doomed to die, but this can not account for the fact that in one experiment in which 30 were operated only 4 remained alive at the end of 33 days.

In another experiment the case was made still more clear. Of 100 operated tadpoles only 7 remained alive at the end of 32 days—of these there had been failure to remove the hypophysis in one case and in another there had probably been partial failure. A control set was reared in which the cut was made as though for removal of the hypophysis, but the gland was left intact. Of the 28 thus treated 14 were alive at the end of 42 days. At this time they were in a very flourishing condition, although the operation caused a temporary retardation of growth.

In other sets of experiments there were usually one or two tadpoles that failed to show the characteristic color change. These were invariably hardy. Upon sectioning them the hypophysis was found intact.

Operated tadpoles and control lots were kept side by side in the same or neighboring aquaria and the operated ones invariably showed heavy mortality while the control tadpoles were healthy. This mortality did not appear until

[2] Smith, P. E., "Experimental Ablation of the Hypophysis in the Frog Embryo," SCIENCE, August 25, 1916, p. 280.

at least a week after the operation, long after complete recovery, and it was not evident in certain cultures so long as they were kept in well water, appearing only after they were placed in our city water.

The interesting thing is that other tadpoles that had undergone a more severe operation in the removal of the thyroid gland showed no appreciable mortality until after the lapse of a month, when they had grown so large as to crowd the aquaria. These were kept in conditions identical with those under which the tadpoles deprived of the hypophysis showed such heavy mortality.

I propose next spring to determine if possible whether this lack of resistance is of a general character or whether the absence of the hypophysis causes a heightened susceptibility to specific injurious substances or conditions.

These experiments upon removal of the hypophysis represent only one phase of my work; similar methods were applied to the extirpation of the thyroid anlage. This was removed at a slightly later stage 6–6.5 mm. total length shortly after it appeared. In this case a transverse cut was made between the heart and the thyroid anlage and the latter was readily removed. In some instances a small portion of it may have been left behind, but in the main the operation proved successful as demonstrated in sections of operated tadpoles. Recovery from the operation was quite as rapid and complete as in the case of hypophysis extirpation. This operation was successfully performed upon 336 tadpoles.

As indicated above, for a long time after the operation the tadpoles showed no ill effects from the absence of the thyroid gland as regards either size or vitality. In fact they appeared in every way normal up to the time when the hind limbs began to form. When they began to die as a result of overcrowding and other unfavorable conditions that became marked at about 6 weeks after the operation, there was an even greater mortality among the controls.

The metamorphosis of the controls began about the middle of July and continued to August 13, when the last control tadpole metamorphosed. Five of the operated tadpoles metamorphosed at about the same time as the controls. One metamorphosed much later—September 20.

At the present date, October 1, twelve operated tadpoles ranging in length from 85 mm. to 123 mm. are living and show no tendencies toward metamorphosis. The hind-limb rudiments are rather uniformly about 4 mm. in length. The knee is evident and the toe points distinguishable. The larval characters as a whole are maintained. The intestine, the mouth, eyes, etc., are all larval in character, although a peculiar modification in the form of the head is noted in that the portion in front of the eyes is lengthened, broadened and flattened dorsoventrally. It is thus clear that the removal of the thyroid gland has caused these tadpoles to remain in a larval condition for a month and a half after the controls have completed metamorphosis. Section of 7 operated tadpoles at various stages from 9 to 24 mm. showed no vestiges of the thyroid gland. A careful study of the operated animals that have undergone metamorphosis is being carried on to determine whether small portions of the gland have remained after the operation or whether there may not have been new formation of thyroid tissue. Upon sectioning one of these a single well-developed thyroid gland was found on one side. This clearly shows that we were here dealing with a case of imperfect removal.

The results of this experiment establish a corollary to the experiments by which Gudernatsch and others have shown that thyroid feeding—hyperthyroidism—greatly accelerates metamorphosis. Conversely, in the absence of the thyroid gland metamorphosis is at least greatly retarded. How long this may continue remains to be seen.

A careful study of the material is being made to observe the effects of the removal of these glands of internal secretion upon the body as a whole and upon the various organs. The results should be especially interesting because we are dealing with material in which the earliest anlagen of these glands have been removed.

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P. S. As this goes to press, November 17, nine of the thyroidless tadpoles are still alive and have increased in size. One has been fed thyroid preparations for 25 days but in very small amounts and at long intervals for fear of fatal results. The hind legs have reached a length of 9.5 mm. and the fore legs are evident beneath the skin. The tail has become greatly shortened and the head is assuming the character of a frog's head. The legs of all the other tadpoles have remained stationary in development at a length of 4 mm. and the tadpoles as a whole show no further signs of metamorphosis. Another tadpole of 29 mm. heavily fed with thyroid, died after 4 days. When compared with a thyroidless tadpole of practically equal body length it was found the intestine of the thyroid fed tadpole had been reduced to a length of 143 mm. as compared with 237 mm., the length of the intestine of the thyroidless tadpole that had not been fed thyroid.

B. M. A.

MICROTECHNICAL METHODS FOR STUDYING CERTAIN PLANT-SUCKING INSECTS IN SITU

A PROBLEM on which the writer has been working for the past year, viz., determining the relation of certain sucking insects to their host plants, has necessitated the development or adaptation of several points of microtechnique which may be of use to other investigators along similar lines. Sectioning insect and plant tissue together has not been attempted often, as the usual methods suitable for one are out of question for the other. It is also necessary to cut quite hard tissues and to employ stains for chitin which also will not dissolve the middle lamellæ separating the plant cell-walls.

The material for study must be fresh. Usually most satisfactory results are obtained if the bottles of killing fluid are taken into the field, the parts of plants bearing the insects cut off with a sharp knife, and immediately immersed. Aphididæ and others of the more active forms must be removed with the part of the plant on which they are feeding and killed before they have time to pull out the proboscis, otherwise their natural positions in feeding can not be studied. For the gelatine method of embedding, which the writer has used quite extensively, pieces of pine needles, each bearing a coccid at one end, are tied in bundles of ten to twenty, making it possible to get sections of many needles at once; with the use of a killing and fixing agent which penetrates rapidly and easily no difficulty from improper fixing of parts of these bundles is experienced.

Of the killing solutions a variety was tried, Jeffry's[1] proving in most cases the most satisfactory, as the picric acid in it stains chitin. Also it softens hard plant tissues so that it is possible to cut paraffin sections of leaves as hard as *Citrus* without further softening. It may be used hot for twenty minutes or cold for several hours. Care must be taken to wash thoroughly in alcohol or iodin alcohol (30 per cent. alcohol which has been turned to a light wine color by the addition of iodin), otherwise crystals of mecuric bichlorid will remain. Carnoy's fluid[2] also proves successful, particularly with active insects having much secretion of wax, *e. g.*, the aphid *Chermes*, which with less quickly penetrating solutions encloses a drop of air, thus enabling the insect to free its beak before death. Its hardening properties are overcome by thorough washing in absolute alcohol, followed by 95 per cent., 85 per cent., 70 per cent., 50 per cent., 30 per cent. strengths, and then softening in Jeffry's solution.

The gelatine method for embedding[3] has been found by the writer very successful for many hard tissues. It deserves extended trial with plant tissues usually considered too hard for sectioning. It is a short method: the material does not require dehydration before its use, therefore hard tissues are not rendered harder than they naturally are. Further, the

1 Corrosive sublimate, saturated solution in 30 per cent. alcohol, 3 parts. Picric acid, saturated solution in 30 per cent. alcohol, 1 part.

2 Absolute alcohol 6 parts, chloroform 3 parts, glacial acetic acid 1 part.

3 Land, W. J. G., "Microtechnical Methods," *Bot. Gaz.*, Vol. 59, May, 1915, p. 400. Chamberlain, C. J., "Methods in Plant Histology," 3d revised edition, p. 128.

natural condition of the structure is maintained, there being but little shrinkage. Cell contents relatively insoluble in water, but soluble in xylol and oils, are not lost. Sections as thin as 10 microns can be cut with ease. However, serial sections can not be cut, nor can some stains be used unless the gelatine is dissolved away after sectioning, which is not easy to do. The method is as follows: Ordinary cooking gelatine is soaked two or three hours, or until it will absorb no more water, then after the excess of water is poured off it is warmed until melted. A temperature of not over 70 degrees Centigrade should be maintained. Part of the liquid gelatine is now thinned with an equal volume of water and the material to be embedded is kept in this dilute gelatine for several hours, during which it must be warm enough to remain liquid. Following this, concentrated gelatine is used similarly for several hours more. The dishes containing the material being embedded should be corked to prevent drying. The material is now cooled in a paper tray coated with paraffin, after which it is hardened for several days in 4 per cent. formalin. The microtome knife must be sharp, with no bevel on the lower side, and set at as great an angle as possible. Either alcohol or water may be used to flood the knife in cutting. Pieces of the gelatine with embedded material are, as a rule, strong enough to be clamped in place in the machine without wooden blocks as supports.

Materials which can not be cut otherwise yield easily to the knife after the use of dilute or concentrated hydrofluoric acid[4] for one to three weeks, which is followed by thorough washing in water, then the regular paraffin method. Ample time for each stage of the paraffin method to permit dehydration and embedding of the large pieces must be given.

Acknowledgment for many suggestions is made to Dr. L. L. Burlingame, of the botany department of Stanford University.

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[4] Bailey, I. W., "Microtechnique for Woody Structures," *Bot. Gaz.*, Vol. 49, January, 1910, p. 58.

THE ECOLOGICAL SOCIETY OF AMERICA

A MEETING of the Ecological Society of America was held in the High School building at San Diego, California, on August 10 and 11, 1916, and two joint sessions were held with the Western Society of Naturalists. About twenty-five members were present, the chair being occupied by the secretary-treasurer. Members of the society participated in the biological dinner at the U. S. Grant Hotel on the evening of August 12. On the afternoon of that day the work of the Scripps Institution was demonstrated by members of its staff. On August 13 and 14 the members of the Ecological Society were guests of the San Diego Society of Natural History on a 200-mile automobile trip to the Cuyamaca Mountains and the edge of the Colorado Desert.

Following are abstracts of papers presented at the sessions of the society:

The First Stage in the Recession of the Salton Sea: D. T. MACDOUGAL.

The Trees and Shrubs of the Grand Canyon of the Colorado: ALICE EASTWOOD.

The zones of plant life in the Grand Canyon may be defined by the trees and shrubs which characterize them. The great diversity of environment results in complexities of distribution which offer a promising field for ecological investigation. Fifty lantern slides were shown, made from herbarium specimens of the leading trees and shrubs of the Canyon, collected on the Bright Angel, Hermit and Berry trails.

Results of the Effect of Chaparral and Forest Cover on Meteorological Conditions: EDWARD N. MUNNS.

Records have been taken daily at three stations at the Converse Experiment Station, for three successive years. One station is located in an open cienega, one in a chaparral field, the third in a forest of jeffrey pine, all stations being about 6,000 feet elevation.

The records show the mean annual temperature under the chaparral cover is 2°.8 higher than in the open, and that of the forest 1°.2 higher. More important are the extremes, the mean maximum in the chaparral, being 5°.7 higher and the mean minimum 2°.0 lower than in the open, while the mean maximum under forest conditions is 1°.4 lower and the mean minimum 3°.8 higher than in the open. The mean daily range in the open is 26°.5, that of the chaparral 7°.7 greater, and that in the forest 5°.2 less.

Soil temperatures are greatest in the open, and least in chaparral with a difference of 1°.0 be-

tween chaparral and forest, and 6°.0 between chaparral and open, the differences being greater in summer and least in winter.

Eighty per cent. of the precipitation reaches the ground under chaparral and seventy-two per cent. under the forest, much more water reaching the ground from snowfall under chaparral than forest. A difference of 5 per cent. exists between open and areas under cover, though there is but slight difference between the types of cover. Evaporation in the forest is 85.2 per cent. that of the open, while the chaparral evaporation is but 47.2 per cent.

Plant Succession in Badlands: Frederic E. Clements.

An account of the revegetation of the highly eroded clays and shales, known as Badlands. The areas considered are the Oligocene-Miocene deposits of the Hat Creek Basin in Nebraska, and of the White River in South Dakota, the Eocene of the Little Missouri in North Dakota and Montana, Miocene volcanic deposits in Wyoming, and the Mancos Shales of Colorado, Wyoming, Utah and New Mexico. In the last, the climax is the *Atriplex-Artemisia* formation of the Great Basin region. In all the others, the climax is the prairie-plains grassland, except in the Black Hills proper, where it is the *Pinus ponderosa* forest. The soil water of the Mancos Shales is saline, and the succession type is the halosere, consisting of halophytes and terminating in a sage-brush climax, or rarely in juniper-piñon woodland. In all the Tertiary Badlands of the Great Plains region, the fine-grained compact soil, the steep slope and the low but torrential rainfall make xerophytic succession, as represented by the xerosere, typical. The hydrosere and halosere are relatively rare, while subseres are especially favored by the nature of the soil. The climax is usually reached in the *Stipa-Agropyrum* prairie association. In drier regions, the climax is the *Bulbilis-Bouteloua* short-grass association, and in wetter ones, the *Pinus ponderosa* consociation.

A Summary of Bog Theories: George B. Rigg.

A discussion of the character and occurrence of sphagnum bogs, and a presentation of the theories that have been advanced to account for the xerophily of bog plants, the possible sources of toxic substances in bog water, and the manner in which these substances influence the activities of plants.

Vital Statistics of the Yellow Pine through an Altitudinal Gradient of Climatic Conditions: Forrest Shreve.

Vital statistics have been secured for *Pinus arizonica* at elevations of 6,000, 7,000, 8,000 and 9,000 feet on south-facing slopes in the Santa Catalina Mountains, Arizona, and on north-facing slopes at 6,000 and 7,000 feet. The number of adult trees (10 cm. and over) per unit area decreases with decrease of altitude, except on the south-facing slopes at 6,000 feet. The total volume per unit area decreases with decrease of altitude, the exceptional stand at 6,000 feet being composed of a relatively large number of small trees. The number of seedlings and smaller trees bears no relation to altitude on the areas examined. Curves were exhibited showing the rate of growth at the four altitudes.

The Influence of Environmental Conditions in the Origin of a Narrowly Localized Race of Mice: Francis B. Sumner.

The Distribution of Pocket Gophers in California: Joseph Grinnell.

On Some Varieties of Thais (Purpura) lapillus and their Relation to the Environment: Harold S. Colton.

On account of its abundance and great variation, *Thais* (*Purpura*) *lapillus* forms a very favorable material for a study of some of the conditions of life on the rocky shores of the New England coast. Over twelve thousand shells were collected and sorted from sixty-seven localities in the neighborhood of Mount Desert Island, Maine. *Thais* is found in the rock association and the boulder association of the littoral formation wherever its food, *Balanus*, the barnacle, and *Mytillus*, the mussel, is found. The environments were classified according to the size of the waves on the beach and on the color and character of the rocky substratum. A study of the varieties showed that (1) in the surf and in the sheltered harbor the snails of a given age were smaller and darker than those found in the bays. More were also apt to be lamellated in the surf or harbor than in the bays; (2) light forms are apt to be found on light-colored rocks, but there is no great correlation between yellow snails and yellow rocks or banded snails on banded rocks; (3) there are other factors which act on a whole region irrespective of the wave action or substratum. An example of this was found in comparing the number of lamellated forms in the Somes Sound region with the Blue Hill Bay region adjoining. In the former, whether in harbor, bay, or surf, lamellated forms are rare (6 per cent.). In the latter they are common in the harbors, as much as 96 per cent. in some, absent in the bay but common (17 per cent.) in the surf.

Thais feeds in this region on barnacles and mussels. It is destroyed (1) by cannabalism within the egg capsule; (2) by fish when young; (3) by herring gulls when old; (4) by shore ice in the winter. A comparison of collections made on islands on which the gulls breed, with situations where there are not so many, seems to show that the proportions of color found are determined by selection.

An Inquiry into the Relative Importance of the Various Phases of the Environment in Determining Plant Distribution: WM. E. LAWRENCE.

This paper presents the results of an inquiry into the literature to ascertain what researches throw light on the problems of plant distribution. It includes a discussion of the relative importance of phylogeny, historic geology, climatic cycles, topography, climatic and edaphic factors as they affect the distribution of plants. The inherited physiological and morphological characteristics of a plant, on account of its phylogenetic relation, are considered first because they define the limit of the plant's response in terms of the environment. Geological factors have, of course, greatly influenced the preceding, but they are equally important in determining the components of the endemic flora. Climatic and edaphic factors are effective at present. Of these no one factor or combination of factors is found to be all dominant. Under certain less variable conditions or combination of factors, the more variable factor or factors appear to dominate the physiological activity of the plant and hence determine its success in such an environment. There are, therefore, no limiting factors in plant distribution except as the conditions are defined. Under proper conditions every known factor in nature may limit growth and reproduction, hence distribution. The control of these conditions one by one is exactly the method of experimentation. When we attempt to analyze the natural conditions, we merely interpret according to the laws of experimentation. There seems to be good reason to believe that the distribution of certain plants and plant associations are in some cases limited by one factor such as water and in other cases by other factors such as temperature. The whole situation is likely to be obscured in nature because of the innumerable possibility of combination and the factors of preoccupation and competition. An ecological classification is presented based upon the greatest variable factor for any given area, whether the area is defined on the basis of physiography, plant association, or other limits.

On the Relation between the Rate of Root Growth and Oxygen: W. A. CANNON.

A series of experiments is reported on in which the roots of *Prosopis velutina* and of *Opuntia versicolor* are exposed to atmospheres of (1) pure carbon dioxide, (2) and atmospheric air so diluted with carbon dioxide that a mixture containing 5 to 25 per cent. oxygen results. It was found that the roots of both *Prosopis* and *Opuntia* can maintain a feeble growth rate in an atmosphere containing as little as 5 per cent. oxygen, but that root growth in both species stops in pure CO_2. The recovery from the asphyxiation occurs sooner in *Prosopis* than in *Opuntia*, and in both at higher sooner than at lower soil temperatures. The results indicate that the response of the roots of *Opuntia* to a diminished oxygen supply, such as occurs with increasing depth beneath the surface of the ground, is a contributory factor among those which bring about the superficial placing of its roots.

The Relation between Marine Biology and Ecology: ELLIS L. MICHAEL.

To understand marine organisms is the function of marine biology. To what extent, how, and why are marine organisms adapted to the particular environments in which they live? In short, by virtue of what is a marine organism marine? This is the central question in marine biology: all others are strictly tributary to it. Fully grasped, this means that the significance of no phenomenon essential to the life of any marine organism can be fully understood so long as any other phenomenon likewise essential to it is entirely ignored. Knowledge of the environment is therefore as indispensable to a complete understanding of marine organisms as is that of the organisms themselves. Continuous and intimately coordinated investigations in chemistry, physics and hydrography as well as in morphology, embryology and physiology are indispensable. There is, therefore, a certain natural order of progress in marine biology. Details can not be stipulated, but this much is certain: after the various organisms to be investigated have been identified, it is necessary to determine how they are related to the elements of their environmental complexes before it will be possible to discover how or why these relations are maintained. That is, the initial step must be one in field ecology. Then would follow the more intensive studies of structure, function and behavior—morphology, embryology, physiology and experimental ecology—required to fully

understand the organism as it actually lives in nature. Not until this has been accomplished may it be truly claimed that an investigation in marine biology has been carried to its logical termination. This same conception, of course, applies to land organisms and fresh-water organisms; to mountain biology, desert biology, lake biology, river biology, etc. It is that conception which insists that no organism can be fully understood, in its structure and function quite as much as in its distribution and behavior, apart from its natural abode.

Variations of Picris echioides: R. R. Gates.

Picris echioides is a European plant introduced into California. In a small colony of this composite at Berkeley several marked variations were observed. The most interesting of these were two individuals in which all the florets of the heads were "quilled" or tubular, instead of all being flat and ray-like, as in the ordinary form. In the normal form the heads open early in the morning, but on bright days they are closed again by noon, while in the quilled variation the heads remain open several hours longer and never completely close. Hence there is a marked difference in the physiological reactions of the two forms. Another variation is in the color of the rays, which are usually dark yellow; but occasional plants occur in which all the rays are pale lemon yellow. Again, the stems are usually green, but occasionally reddish throughout. There are also great differences in size, which are very probably genetic in nature. The shortest plants are slender and only 18 inches high; while the tallest are very stout, differ in their branching, have much larger leaves and reach nearly 5 feet in height. Other differences can also be observed, indicating that a considerable number of genetic variations exist in this interbreeding population. It is not known whether similar variations occur in this species in its natural European home.

Forrest Shreve,
Secretary-Treasurer

SOCIETIES AND ACADEMIES

THE AMERICAN MATHEMATICAL SOCIETY

The one hundred and eighty-sixth regular meeting of the American Mathematical Society was held at Columbia University on Saturday, October 28, extending through the usual morning and afternoon sessions. The attendance included thirty-nine members. President E. W. Brown occupied the chair. The council announced the election of the following persons to membership in the society: Mr. A. C. Bose, Calcutta, India; Professor L. C. Emmons, Michigan Agricultural College; Professor A. M. Harding, University of Arkansas; Dr. W. L. Hart, Harvard University; Dr. J. R. Musselman, University of Illinois; Mr. S. Z. Rothschild, Immediate Benefit Life Insurance Company, Baltimore, Md.; Professor Pauline Sperry, Smith College. Six applications for membership were received.

Committees were appointed to audit the treasurer's accounts and to arrange for the annual meeting in December and the summer meeting of 1917.

The following papers were read at the October meeting:

Mrs. J. R. Roe: "Interfunctional expressibility problems of symmetric functions."

E. D. Roe, Jr.: "A geometric representation."

E. D. Roe, Jr.: "Studies of the Kreisteilungsgleichung and related questions."

E. D. Roe, Jr.: "The irreducible factors of $x^n + x^{n-1} + x^{n-2} + \cdots + 1$."

H. B. Mitchell: "On the imaginary roots of a polynomial and the real roots of its derivative."

J. H. Weaver: "Some properties of parabolas generated by straight lines and circles."

F. N. Cole: "Complete census of the triad systems in fifteen letters."

O. E. Glenn: "Translation surfaces associated with line congruences."

O. E. Glenn: "Methods in the invariant theory of special groups, based on finite expansions of forms."

R. L. Moore: "A theorem concerning continuous curves."

J. R. Kline: "The converse of the theorem concerning the division of a plane by an open curve."

H. S. Vandiver: "Note on the distribution of quadratic and higher power residues."

H. S. Vandiver: "The generalized Lagrange indeterminate congruence for a composite ideal modulus."

The annual meeting of the society will be held at Columbia University on Wednesday and Thursday, December 27–28. At this meeting President Brown will deliver his retiring address, on "The relation of mathematics to the natural sciences." A regular meeting of the society will also be held in Chicago December 22–23. The San Francisco Section will meet at the University of California on Saturday, November 25. The Southwestern Section will meet at the University of Kansas on Saturday, December 2.

F. N. Cole,
Secretary

SCIENCE

FRIDAY, DECEMBER 1, 1916

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

THE COST OF COAL[1]

THE price of coal is a matter of vital concern to the average citizen. No less important, however, is the question what our coal actually costs to produce and the interest in this subject is typical of the popular interest in the large productive enterprises of the country. As citizens we recognize the consumer's dependence upon the producer and are taking advanced ground as to their relative rights. In few industries does this dependence seem more vital or the consumer's equity appear larger than in that of producing and selling coal. The per capita annual expenditure for the useful metals is roughly equivalent to that for coal, but few citizens purchase pig iron or bar copper, whereas of the urban population only the dwellers in apartments, boarding-houses and hotels are spared the necessity of buying coal. The consumption of coal in the United States for heating and cooking is between 1 and 1½ tons per capita. A careful estimate for 1915 is 1.1 tons, which happens to be identical with the figure determined for similar consumption in Great Britain in 1898. This non-industrial consumption is greatest in cities and in this city of Chicago in 1912 it was nearly 2 tons. Of course every citizen indirectly pays for his share of the total consumption, which last year amounted to 4.6 tons per capita.

Again it may be that because to a larger degree the cost of metals is charged to capital outlay rather than to the operating expense of life, we appreciate less keenly the unit price of these materials that are

[1] Read before the American Mining Congress, Chicago, November 14.

not immediately consumed with the using. At any rate, public opinion is more easily brought to a high temperature by considering the price of coal than by considering the price of any other product unless we except gasoline, recent discussion of which has been almost explosive.

Looking backward as well as forward, one need not be an alarmist to suggest that in the whole field of productive business the coal industry seems the one most likely to be threatened with government operation. The foodstuffs are produced on land owned and operated by the millions, and so far as the production of the raw material for them is concerned, "monopoly" is an unknown word, but when we think of coal, terms like "barons" and "trusts" instinctively come to mind. For these reasons the determination of certain facts connected with coal production and the analysis of the cost elements that enter into the price of coal constitute a timely subject for discussion.

In discussing costs, however, we do not overlook the too evident fact that at times price may far outstrip cost. The price of coal depends upon the balance between necessity for fuel, on the one hand, and ability to produce and to deliver, on the other; the ability to produce is in turn controlled by the labor available and the ability to deliver is dependent upon car supply. Increased foreign demand for American coal, large industrial consumption, unusual weather—all may have great influence on the current price of coal, but none of these is to be considered a factor in the actual cost of production except so far as it causes irregularity in operating expenses and promotes a decrease in efficiency of mine labor. To-day high prices are being received for coal by those who are able to produce and deliver more than their outstanding contracts require. In other words, a few traders may be able and willing to capitalize the urgent necessity of the consumer and their own ability to deliver. The premium for fuel now being paid generally by the consumers of the country and by such traders as have been caught short in their contracts is in reality not properly chargeable to cost of coal, but to cost of car and labor shortage, just as in the times of stress accompanying labor troubles the premium paid by their consumers is a part of the price the country pays for strikes.

Four general items of cost must be considered as normally controlling the price of coal to the consumer—resource cost, mining cost, transportation cost and marketing cost. Under usual conditions each of these items includes a margin of profit which may seem either excessive or inadequate, according to your point of view. Yet an unbiased consideration of these cost items is absolutely essential as a preliminary to the decision by the public whether we are buying coal at a fair price, and if not why not. As long as it is the popular view that the price of coal is made up of one part each of mining costs and freight costs to two parts each of operator's profits and railroad dividends, with the cost of a certain amount of needless waste on the side, the demand for investigation will continue, and in so far as there is any element of truth in this view, legislative action is justified, even though the prescribed reform may approach the extreme of public ownership and operation of mines and railroads.

As the initial item of cost, the amount charged against the marketed product as the value of the coal in the ground, which for brevity may be termed the resource cost, is perhaps the item most often overlooked by the coal consumer, and for this reason that phase of the subject will be fully considered after the other items are

treated. These other items need less discussion in this paper for several reasons: the item of marketing cost is one that can be brought directly under observation by the consumer if he will but study the matter intelligently, the transportation cost can be learned by simple inquiry and its control lies within the province of the Interstate Commerce Commission, and the details of mining cost can best be set forth by the mine operators themselves, for they have now adopted the policy of free discussion of these matters, which they once regarded as sacred from public view. The purpose of this paper, then, is simply to give a summary statement of all these elements in the cost of coal, and some special discussion of the resource cost. In presenting the subject, the senior author assumes responsibility for whatever may be regarded as mere expressions of opinion and the junior author stands behind the statements of fact.

The item of cost first to be considered represents that part of the value given to the ton of coal by the mine operator and the mine worker. This may be termed mining cost, but it must include the operator's selling costs and other overhead expenses as well as the mining costs proper, which include the larger expenditures for wages, supplies and power. This cost plus the resource cost—the royalty or depletion charge—and the profit or loss on the sale make up the value at the mine mouth. The mining cost varies not only between mines of different companies in separated fields, but even between adjacent mines of the same company in the same field. Both nature and man contribute to such variation.

It is not practicable to assign a very exact figure to the mining cost—the census of 1909 indicated an average of $1 a ton for bituminous coal and $1.86 for anthracite, but these figures are believed by some operators to be too low. It is possible, however, to show in a general way the distribution of this item; the cost of mining is divided between labor, 70 to 75 per cent.; materials, 16 to 20 per cent.; general expense at mine and office and insurance, 2 to 4 per cent.; taxes, less than 1 per cent. to 3 per cent. for bituminous coal, and 3 to 7 per cent. for anthracite; selling expenses, nothing to 5 per cent., and recently to these items has been added the direct and indirect cost of workman's compensation, which may reach 5 per cent. for bituminous coal. The charges for labor, material and general office expenses are easily understood, as is also a charge for depreciation of plant and machinery; but taxes and selling expenses are important items that may be overlooked by the casual observer. Some figures recently published show that the taxes levied in West Virginia last year on coal lands and coal-mine improvements—that is, on the industry as a whole—were equivalent to nearly 3 cents per net ton of coal produced, which is doubtless fully as much as the profit made by many of the operators in that state.

The cost of selling coal is nothing for the companies that use their own product, including the steel corporation and a large number of others, and is little or nothing for the producers who sell nearly all their coal to such large consumers as the railroads. Companies that produce coal for domestic use and the general run of steam trade must figure on a selling cost as high as 10 cents or more per ton, the cost depending on the extent of their business. The average selling cost for bituminous coal is probably 5 to 10 cents a ton, and for anthracite the usual charge of sales agencies is reported as 10 cents a ton for steam sizes and 15 cents for the prepared sizes.

The producers of coal and the transportation companies are concerned not so much with the actual rates charged for carrying coal as with the adjustment of rates between different coal fields and between different markets. In the many years in which our coal industry has been developing, rate structures have been built up that give to this and that producing district differentials over other districts—"handicaps," as it were—that may be based on comparative lengths of haul or on the ability of the coals to compete by reason of difference in quality or in cost of mining or perhaps may be merely the survival of past practise, for which no reason now exists. The consumer of coal, however, is interested in the actual rather than the relative freight rate.

To help toward a realization of the magnitude of this transportation item, it may be pointed out, first, that all but 14 per cent. of the output of the country's coal mines, aggregating 532 million tons, is moved to market by rail or water, and second, that nearly half of the bituminous coal (47 per cent. in 1915) and more than two thirds of the anthracite (71 per cent. in 1915) is shipped outside of the states in which it is produced.

Add to this statement of the extent to which coal enters interstate commerce a glance at the distribution of centers of maximum production and maximum consumption—the New York–Baltimore industrial zone, which has a total per capita consumption of nearly 10 tons and lies 100 to 400 miles from the tributary coal fields; New England, consuming about 7 tons to the unit of population and lying 400 to 800 miles from its coal supply; or the populous industrial district of which Chicago is the commercial center, consuming 8 to 9 tons per capita of coal in part hauled more than 400 miles from the fields of West Virginia and eastern Kentucky and in part 200 miles or less from the Illinois mines. With these facts in mind we must realize that the transportation cost is necessarily a large part of the country's fuel bill.

As has already been suggested, the transportation rate in force from any coal field to any market can readily be learned by the consumer who wishes to figure this item in the cost of the coal he buys. Therefore in the present general consideration of the subject it is sufficient to state the average value of this item. In the interstate traffic, both rail and water, bituminous coal probably pays an average freight of nearly $2 per ton. In other words, the transportation costs more than the product and, as some parts of the country are just now learning, is sometimes more difficult to obtain. The value of coal, like the value of so many other commodities, is a place value.

The average freight charge on anthracite is higher than that on bituminous coal, first because the rates are higher and second because, according to the reports of the Interstate Commerce Commission, *all* movement considered, the coal is carried a greater distance.

The cost of handling the coal, exclusive of freight, from the time it leaves the producer until it is in the consumer's fuel bin, may be termed the marketing cost. It can readily be seen that a large part of the coal produced is not subject to this cost, for most large users of steam coal, such as the railroads and the coke manufacturers, place contracts directly with the producing companies or their selling agencies and buy in the open market only when their needs exceed the deliveries under their contracts. Much of the coal, however, both anthracite and bituminous, passes through the hands of a wholesale dealer or jobber before it is received by the retail dealer who puts it in

our cellars or in the bins of a power plant. Coal that gets a long way from the mine may pass through many hands before it reaches the consumer, and it not only pays commissions all along the line, but is subject to shrinkage and deterioration, both of which enter into the final selling price to the consumer. Brokers are usually satisfied to make a gross profit of perhaps 10 cents a ton, but as several brokers may make a "turn over" on the same car before it is unloaded this element of cost may be several times that amount.

About half of the anthracite and around 15 per cent. of the bituminous coal is retailed in less than carload lots, and the greatest number of individuals are directly concerned in the marketing of this portion, regarding the profits on which there is the widest divergence of opinion. The margin in the retail business between cost on cars and price delivered is between $1.25 and $2.00 a ton and is not more than enough to give on the average a fair profit. The shrinkage and, in part, the deterioration are together seldom less than 1 per cent. of the weight and may exceed 4 per cent., and the retail dealer also must provide in his selling price for uncollectable accounts.

Advertising is a large expense—in part carried by the retailer directly, but all borne by the industry. The largest single item in the cost of retailing is of course that representing the labor of handling and the local cartage, which together make up about half the marketing cost.

There now remains to be considered the first major item, or the resource cost, which is what the operator has to pay for the coal in the ground—the idle resource, which he starts on its career of usefulness. This cost is expressed as a royalty or a depletion charge.

One of the latest leases by a large coal-land owner provides for the payment of 27 per cent. of the selling price of the coal at the breaker. This percentage is therefore not only a royalty figured on the mineral resource, but also a commission based on the miner's wage. To bring this right home to you and to me, it may be said that the practical result is that if the anthracite we burn in our range this winter happens to come from that particular property, we will pay fully $1 a ton into the treasury of the city trust that owes its existence to the far-seeing business sense of a hard-headed citizen of Philadelphia. Whether such a royalty is excessive or not, the fact remains that this is the tribute paid to private ownership.

The present average rate of royalty on anthracite is probably between 32 and 35 cents a ton on all sizes, which is from 12 to 14 per cent. of the selling value at the mine. The minimum rate (about 10 per cent.) is found in some old leases, and the maximum (20 to 27 per cent.) in leases made in the last five years. R. V. Norris states that in the late sixties, when the annual output of anthracite was around 15,000,000 tons, royalties were 8 to 10 cents a ton on prepared sizes, but that no charge was made on the smaller sizes. In the seventies the rate rose to 25 cents on prepared, one half that on pea, and one fourth on smaller sizes. By the middle eighties, when the output was a third what it is now, the rate was about double that of the seventies—that is, 40 to 50 cents on the larger sizes and 5 to 10 cents on the smaller sizes. The tendency is still upward by reason of increases in the rates for intermediate sizes and the operation of royalty rates based on a percentage of the selling value, an increasing quantity. Figured on the output from the Girard lands, which is nearly 3 per cent. of the total production, the gross return to the estate from its coal lands is over 50 cents a ton.

Nor is the increase in value of anthracite lands any less striking. At the beginning of the last century, as stated by Mr. Norris, the great bulk of these lands were patented by the State of Pennsylvania for $2 to $4 an acre; in the middle of the century the price of the best land rose to $50, and in 1875 even to $500. Now $3,000 an acre has been paid for virgin coal land, and little is on the market at that. In considering these increases in land values, the effect of interest and taxes must not be overlooked.

The bituminous coal industry is a modern institution compared with the mining of anthracite, and much of the bituminous coal land was acquired by the operating companies during the last twenty years for little if anything more than its surface value. To-day there are large areas of bituminous coal-bearing lands that, because they are undeveloped and without railroads, can be purchased at a low price, but little or no anthracite land is on the market, and little has changed hands for years. The present average resource cost of bituminous coal is not much over 5 cents a ton, or about 4 per cent. of the average selling value at the mine. In the Pocahontas region and the Pittsburgh district the royalties are much higher, but these, like others that might be cited, are exceptions—one due to coal of special quality, and the other to location—factors which, incidentally, are exactly those that have assisted in making the resource cost of anthracite what it is.

Should you be interested in summing up all these various costs and striking a balance between labor's share and capital's return, you would find that the mine worker, the trainman, and the wagon driver together receive fully half of the price of the anthracite delivered at your house, and the same three classes of labor receive not less than half the price paid by the average consumer for the cheaper soft coal. In a similar manner the average return on the capital invested in land, mining plant, railroads and coal yard may be roughly calculated, with the result that landlord, bondholder and stockholder of coal company and railroad together receive about $1.15 from the ton of anthracite and only 50 to 75 cents from the ton of bituminous coal, and of either of these amounts the mine operator's share is only a small fraction.

It is not the purpose of this analysis of costs to offer any cure-all for the high price of coal, yet some comment on the facts presented may possess value. At least certain lines of approach can be pointed out as not very promising. For example, any one who is at all cognizant of the trend in price of labor and material can see little hope of relief in lower costs for these items. Furthermore, observation of the advances made in mining methods in the last decade or two affords slight warrant for belief in any charge of wasteful operation. As consumers of coal we might do well to imitate the economy now enforced by the producers in their engineering practise. In the northern anthracite field machine mining in extracting coal from 22- and 24-inch beds, and throughout the anthracite region the average recovery of coal in mining is 65 per cent., as against 40 per cent. only twenty years ago. Nor are the bituminous operators any less progressive in their conservation of the coal they mine.

Yet it must be remembered that conservation of a natural resource, though it will undoubtedly be of direct economic benefit in the future, is not essentially a cheapening process; in fact, these increased recoveries of coal have in large part become possible only because of a higher market price. And, following further this line of thought, we may say that the increased

safety in the coal mines that has come through the combined efforts of the coal companies, the state inspectors, and the Federal Bureau of Mines necessarily involves some increase in cost of operation, but the few cents per ton thus added to the cost is a small price to pay for the satisfaction of having the stain of blood removed from the coal we buy. That form of social insurance which is now enforced through the workman's compensation laws alone adds from 2 to 5 cents a ton to the cost of coal.

In the item of transportation perhaps the most promising relief is that of reducing the length of haul. Though many a consumer's preference for coal from a distant field over that from a field nearer home is based on special requirements, the deciding element in the preference of other consumers is simply the price, and this in turn may be largely due to a differential freight scale, which is thus not in the public interest if we admit the premise that it is wasteful to burn coal in hauling coal into coal districts or past such districts, except in so far as quality requirements absolutely demand the long-haul coal. The recent eastward movement of the higher-grade coals, in part caused by the expert demand, may involve some increase in the average length of haul and thus in the transportation cost of coal not exported, but, on the other hand, this enforced adjustment may lead some consumers to discover nearer home sources of coal equally well suited to their purposes.

Reduction in marketing costs is a reform so close to the consumer that he should be able to find for himself whatever relief is possible. Professor Mead, of the University of Pennsylvania, is authority for the statement that the delivery of coal is costing the dealers 50 cents a ton more than is necessary.

There only remains, therefore, the first item of all—the value of the coal in the ground, or rather the return which the land-owner is asking for this natural resource. The fortunate holder of coal land, whether a very human individual or a soulless corporation or a large trust estate administered for benevolence only, is likely to endeavor to get all that the traffic will bear. Especially in the possession of a limited resource like anthracite, the tendency has been and will continue to be to increase royalties as the years pass, and the only penalty imposed by the state for high royalties seems to be high taxes, which too often, indeed, serve to justify the high resource cost put upon coal in the ground. Finally, in considering royalty rates or depletion charge we must not overlook the interest that accumulates throughout the period between the purchase of the coal land and the removal of the last ton of coal.

In placing a value upon the Choctaw land some years ago the Geological Survey figured the aggregate royalties at current rates as 160 million dollars, but if that amount of royalty were to be collected through the six or seven centuries required for mining the 2,000 million tons under this land, the present value of the land would be only 6½ million dollars if purchased by the federal government or only 4 million if purchased by the state of Oklahoma, and even less if the project were financed by a corporation that would need to issue 6 per cent. bonds. Such is an illustration from actual experience in coal-land valuation—the 4 or 6 million dollars invested in these Oklahoma coal lands now would require a final return of 160 million dollars in royalties to balance the account.

More recently Mr. Cushing, the editor of *Black Diamond*, has figured the cost of a monopolistic control of the available coal resources east of the Rocky Mountains on

the basis of the United States Geological Survey estimate of 2,000,000 million tons. At a valuation of coal in the ground of only 1 cent a ton, which he stated is less than has been paid for large holdings, this deal would require a capitalization of 20 billion dollars, and the fixed charges on the bonds of this United States Coal Corporation would require an interest charge alone of $2 a ton against a production of 600 million tons a year. Mr. Cushing characterizes such a financial undertaking in mild terms as hopelessly impossible, and yet his figures, which do not include taxes, are most enlightening as affording some measure of the cost of possessing an undeveloped resource. Incidentally, these startling figures furnish a strong argument for the present policy of the national government in retaining ownership of the public coal lands, at least up to the time when the market conditions justify the opening of a mine and then either leasing or selling a tract only large enough for that operation. The consumer of the next century simply can not afford to have private capitalists invest to-day in coal land for their great-grandchildren to lease.

The burden that seems inevitable under unregulated private ownership of a natural resource like coal is that because the lands containing these national reserves of heat and power are taxed and because the individual or corporation properly charges up interest at current rates on his large holding, the consumer must pay a resource cost which takes into account the long period of undevelopment. Even the high rates of royalty on the lands of the Girard estate may be found less excessive than they seem if a century's taxes and interest charges are figured. Yet the fact remains that the royalty for anthracite represents a much larger proportion of the cost of the mined coal than any bituminous royalties. Moreover, we believe the highest royalty prevailing in the anthracite region has far more influence in fixing the selling price than the lower rates of the older leases.

Any study of costs in the coal industry finds its point in the question not who, but what, fixes the price of coal. The cost of mining coal, like the cost of living, is increasing. Exact mining costs, however, can not be determined until the operators have accomplished their reform of standardizing accounting. Too often the operator includes in his account only the two largest and most obvious items, labor and material. Thus, when the market for bituminous coal is dull, the company whose land costs little or nothing is able to set a lower limit of price than the company whose coal must stand a charge of 5 to 10 cents per ton or even more, be that charge called royalty, depletion or amortization. At such time the operator with the large resource cost must sell at a real though not always recognized loss, but of course with the hope of recouping himself at times of high prices like the present, if fortunately he has any coal to sell not already contracted for.

Even with the average low resource cost of bituminous coal, the state of competition that is tied up with idle and half-worked mines results in an average total cost that is little below the average selling price. Of course in this business there are those, both large operators and small, who make a profit in lean as well as in fat years, just as there are those for whom the prosperous years are too infrequent to keep them out of the hands of receivers.

In the anthracite fields the mining costs, and especially the resource costs, are higher. But here, with an average market demand that normally exceeds or at least equals the available supply (and with the passing

years this disparity must be expected to increase), there results naturally a lack of competition for the market. Even gentlemen's agreements are unnecessary so long as every operator can reasonably expect to sell his product, and the market price of anthracite at the mine must therefore tend to be fixed by the operator who has the largest mining and resource cost rather than by his neighbor who may be doubly favored with a mine less expensive to work and a lease less exacting in terms.

Confessedly, this analysis of the cost elements that enter into the price of coal emphasizes our lack of specific facts, which can be supplied in the future only through "installation of uniform cost-keeping methods and uniform and improved accounting systems," to quote from the declaration of purposes of the Pittsburgh coal producers. With the results of such bookkeeping in hand, more definite reply can be made to the public's appeal for relief from high prices. Yet even now it may be possible to suggest how that relief will eventually be obtained. Study of present conditions in the coal-mining districts fails to encourage the idea of governmental operation of the seven thousand coal mines in this country. More in line with the trend of public sentiment in the last decade, however, is governmental control in the interest of the consumer by regulation of prices, and to judge from the facts of experience in the regulation of transportation of other public utilities, the public coal commissions will be given sufficient discretionary powers to safeguard the interests of producer and consumer alike, and even mandatory requirements, either legislative or executive, will be subject to judicial review.

Competition seems to have failed of late years to benefit the consumer of coal. In the bituminous fields the competition, whenever present, has been wasteful and in the anthracite fields there has been practical absence of healthy competition, and whether too great or too little competition, the result is the same—to increase the actual cost of bituminous coal by saddling the industry and its product with the fixed charges on idle or semi-idle mines and to raise the price of anthracite coal by favoring the burdens of high resource costs.

In estimating the aggregate losses incurred by society by reason of the large number of mines not working at full capacity, the facts to be considered are that the capital invested in mine equipment asks a wage based on a year of 365 days of 24 hours, while labor's year averaged last year only 230 days in the anthracite mines and only 203 days in the bituminous mines, with only five to eight hours to the day.

As coal is more an interstate than intrastate commodity, any regulation of prices needs to be under federal control, and to benefit both consumer and producer such control can not stop with transportation and mining costs, but must stand ready to exercise full rights as a trustee of the people over the coal in the ground. The private owner of coal land, which derives its real value from society's needs, has no more sacred right to decide whether or not that coal shall be mined when it is needed by society or to fix an exorbitant price on this indispensable national resource than the coal operators have to combine for the purpose of exacting an excessive profit from the consumer, or the railroads to charge all that the traffic may bear. The proposal to bring landowner under the same rule as mine operator and coal carrier may seem radical, but where is the point at which coal becomes the resource upon which industrial society depends for its very life?

Public regulation, however, will be fair, and indeed in the long run will prove beneficial to the landowner as well as to the consumer, to the mine worker as well as to the operator, because any such agency as the

Federal Trade Commission, in its control of prices, must determine costs; and as we interpret the present attitude of the whole coal-mining industry the operators are willing to rest their case on a fair determination of actual costs on which their profits may then be figured.

Geo. Otis Smith,
C. E. Lesher
United States Geological Survey

JOSIAH ROYCE[1]

Josiah Royce died September 14, 1916, aged nearly sixty-one. He was born at Grass Valley, California, November 20, 1855. At sixteen he entered the University of California. There he came under the teaching of the geologist, Joseph LeConte, a pupil of Louis Agassiz; and this teaching Royce himself estimated as one of the greatest philosophical influences of his early life. There also he first became known to Daniel Coit Gilman, who was then the president of the university. Royce received his bachelor's degree in 1875, and left at once for a year of study in Leipzig and Göttingen. At the same time, Gilman was called to Baltimore to "launch" the Johns Hopkins University; and thither he summoned Royce to be one of the first twenty fellows on the opening of the new university in September, 1876. Two years later, in 1878, he received the doctorate at Baltimore, and then returned to Berkeley, where for four years he taught English and incidentally logic. In 1880 he married Katharine Head, and to her unfailing devotion and helpfulness the public acknowledgments of her husband's prefaces bear ample witness. In 1882, he was called to Harvard to fill a temporary vacancy occasioned by the absence of William James, and in 1885 he was appointed assistant professor. Not long after came a nervous breakdown so serious that he made the voyage to Australia in a sailing-vessel, and with happy result. In 1892 he was made professor, and in 1914, on the retirement of Professor Palmer, he became Alford professor of natural religion, moral philosophy and civil polity.

During his fruitful career as scholar and writer and teacher, he grew steadily in renown and influence. He was regarded with constantly deepening love by those who knew him, and with increasing admiration by the great company of those who read his books and heard his lectures. He received honorary degrees from Johns Hopkins, Aberdeen, Yale, St. Andrews, Harvard and Oxford. He was Ingersoll Lecturer at Harvard in 1899, and Walter Channing Cabot Fellow from 1911 to 1914. He was Gifford Lecturer at the University of Aberdeen, 1898 to 1900, and lecturer on the Hibbert Foundation at Manchester College, Oxford, 1913.

He died in the fullness of his intellectual powers, and with his fame still in the ascendant. During the last summer he heard of his election to an honorary fellowship in the British Academy. At the meeting of the American Philosophical Association, held in Philadelphia in December, 1915, he was honored as no American philosopher has been honored during his lifetime. Two sessions were devoted to papers concerning his philosophy and teaching (since published under the title "Papers in Honor of Josiah Royce on his Sixtieth Birthday"); and there was no member of the association who did not feel that he had a debt to acknowledge. Royce was able to receive such homage with the sincerest modesty and with a radiant kindliness and broadcast affection that made him loved even by those who never saw him except in public. He was a natural leader in any community of scholars, but his superiority, though it was masterly in quality, was both fatherly and brotherly in its feeling. During the last year of his life he was rarely able to forget the awful tragedy of the war. Many will feel that he reached the climax of his greatness when, at Tremont Temple on January 30, 1916, he became the inspired vehicle of a righteous indignation. His remarkable address, which at once made Royce a great public figure, is soon

[1] Minute on the life and services of Professor Royce placed upon the records of the faculty of arts and sciences, Harvard University, at the meeting of November 7, 1916.

to appear with other writings of his upon the war, under the title "The Hope of the Great Community." It is the last memorial of himself which his own hands fashioned and his own heart quickened.

Both the teaching and the writing of Royce testify to the extraordinary range of his attainments. Philosophy is wide, but Royce was wider. His prodigious memory, his powers of observation, and his linguistic versatility gave him a general equipment that few men of his day have possessed. In his earlier years he was a historian and a novelist. He was a wide reader and an acute critic of literature. He made permanent contributions to psychology. He was renowned as a moralist, and as a philosopher of religion. But during the later part of his life, logic and methodology became his favorite field of research. His eminence in this field, both as teacher and as writer, was not a little due to his remarkable grasp of mathematics and the physical sciences. Perhaps no man of his time knew so much about so many things and knew it so well. His knowledge of the special sciences was respected even by specialists. His most notable contribution to the teaching of the university was made through his seminary in logic, which became a veritable clearing-house of science. Men of widely different training and technique—chemists, physiologists, statisticians, pathologists, mathematicians—who could not understand one another, were here interpreted to one another by Royce, who understood them all. But he could do even more than that. He could interpret each man to himself, divine nis half-thoughts and render them articulate.

Here is enough to make a great man. But to most persons, his peculiar metaphysics, known to many Harvard men as "Philosophy 9," and to thinking people everywhere through his volume entitled "The World and the Individual," will remain his principal monument. Royce's metaphysical thought was audaciously speculative; but to him speculation was the opposite of guesswork—it was a severe analysis of the certainties that lie at the basis of knowledge. When he asserted the existence of an all-comprehending mind, it was not as a probable hypothesis, but as a necessity of thought, implied in every act of judgment, even in our errors. Much of the fascination of his early work is due to his willingness to accept the weakest link in human intelligence as the support of the weightiest conclusions. His doctrine of reality as an absolute mind numbers him among the idealists in metaphysics. In the works which followed "The Conception of God," he was more inclined to express the nature of reality in terms of purpose than in terms of thought, and thus he came so far into agreement with the school of pragmatism. But since he regarded truth as dependent not on changing human interests, but on a single and eternal will, he distinguished his own doctrine as "absolute pragmatism." Royce was not one of those thinkers whose concern for the unity of existence obscures the sense of its pluralism and variety. "The World and the Individual" undertakes to determine the place of human personality in the life of the whole; and his solution finally embodied itself in his conception of the community. It is through loyalty to common causes that men must win both selfhood and freedom; and the goal of human endeavor is membership, through such loyalty, in the Great Community, which is the "city of God."

An estimate of Royce as an eminent man of science would be futile indeed unless coupled with some judgment as to the practical influence which his deep and subtile thinking had upon his own life and the life of his fellows. To him the great ultimate questions were not simply interesting scientific problems that challenged his intellect; they were also matters of intensely practical import for the spiritual quickening of his fellow-men. His personality, as it developed from that of the shy youth to that of the grave and gentle sexagenarian, was informed by a wideness of moral vision and a loftiness of moral standards that set him apart from the common. He could see the true values of things. This inspired and inspiring vision of the eternal realities enabled him not only to bear the severest blows of personal affliction with courage and serenity,

but also to awaken many a slumbering soul to a larger and nobler life. By precept and example he set forth worthy ideals of virile scholarship, of genuine religion, of civic, national and international righteousness. His spirit, reverent and fearless and tolerant, loving and loyal, still lives in his disciples. Who shall say when its workings will end? His place in the history of speculative philosophy is secure. He, being dead, yet speaketh, and we have no need to grieve. But in the fresh sorrow for our loss, we mourn for Royce as the man and the moulder of men.

THE SCIENTIFIC EXHIBIT OF THE NATIONAL ACADEMY OF SCIENCES

At the recent meeting of the National Academ of Sciences at Boston, there were arranged at the Massachusetts Institute of Technology, an interesting series of scientific exhibits, which were explained by the exhibitors in person. The exhibits were as follows:

H. S. White, Vassar College. Graphic representations of triad systems.

Frank Schlesinger, Allegheny Observatory, Allegheny, Pa. Photographs of Jupiter.

Miss A. J. Cannon, Harvard College Observatory. Stellar spectra.

Leon Campbell, Harvard College Observatory. Visual observations of variable stars.

Miss H. S. Leavitt, Harvard College Observatory. Photographic magnitudes.

Solon I. Bailey, Harvard College Observatory. Variable stars in clusters.

A. G. Webster, Clark University. Acoustical measuring apparatus: standard phone, phonometer and phonotrope. Application of a drop chronograph for use in ballistics.

Charles A. Kraus, Clark University. A new vacuum pump and a new thermostat.

H. P. Hollnagel, Massachusetts Institute of Technology. Methods of isolating the infra-red region of the spectrum.

Alexander McAdie, Blue Hill Observatory. Cloud studies, wind structure and snow flakes.

Ellsworth Huntington, Milton, Mass. The relation between solar changes and barometric gradients. Optimum temperature for the human race.

Robert DeC. Ward, Harvard University. Weather types of the United States, illustrated by composite weather maps and instrumental records.

R. A. Daly and H. Clark, Harvard University. Design for a deep-sea thermograph.

Frank Hall, Massachusetts Institute of Technology. A thermophone arranged so that direct comparison may be made with a magnetic receiver.

A. H. Gill, Massachusetts Institute of Technology. Tests of lubricating mineral oils.

F. G. Keyes and J. B. Dickson, Massachusetts Institute of Technology. Continuous flow calorimeter for measuring heats of reaction in solution.

C. L. Burdick, Massachusetts Institute of Technology. Determination of crystal structure by X-rays.

R. E. Wilson, Massachusetts Institute of Technology. Apparatus for maintaining pressures of one tenth micron or less, and the investigation of the mechanism of chemical reactions.

Henry Fay, Massachusetts Institute of Technology. Erosion of large guns.

Albert Sauveur, Massachusetts Institute of Technology and Harvard University: (1) Photomicrographic apparatus (original). (2) Photomicrographs of metals and alloys; charts and diagrams; specimens.

H. O. Hofman, Massachusetts Institute of Technology. (1) Jenny flotation machine. (2) A laboratory revolving horizontal roasting furnace heated electrically and rotated in the same way.

A. E. Kennelly and Associates, Massachusetts Institute of Technology. Researches in electrical engineering.

Alexander Klemin, Massachusetts Institute of Technology. Aeroplane models used in wind tunnel.

W. Lindgren and W. L. Whitehead, Massachusetts Institute of Technology. Photomicrographs of silver ores from Chile and Tintic.

C. H. Warren, Massachusetts Institute of Technology. (1) A graduated sphere for crystallographic work. (2) Photographs of spherulites in polarized light.

Charles Palache, Harvard University. Models showing gnomonic crystal projection.

Wallace W. Atwood, Harvard University. The former glaciers of the San Juan Mountains of Colorado. The physiographic stages in the evolution of the San Juan Mountains of Colorado.

J. B. Woodworth, Harvard University. Glacial map of Cape Cod and adjacent islands. A glypolith from Nantucket.

Laurence La Forge, U. S. Geological Survey. Recent topographic and geologic maps of New

England and other parts of the United States.

JOHN M. CLARKE, State Museum, Albany, N. Y. Portfolio of paleontological plates, in press. Plates of "Wild flowers of New York," in press. Geological map of Ogdensburg, N. Y., and vicinity, in press.

H. W. SHIMER, Massachusetts Institute of Technology. Evolution of some brachiopods.

RICHARD M. FIELD, Harvard University. Ordovician rocks and faunas of central Pennsylvania.

W. B. SCOTT, Princeton University. Proofs of plates for forthcoming report on paleontology of Patagonia.

W. J. V. OSTERHOUT, Harvard University. Pigments produced by the oxidation of a colorless plant chromogen.

CHARLES W. JOHNSON, Boston Society of Natural History. Distribution and variation of *Helix hortensis*.

JOSEPH A. CUSHMAN, Boston Society of Natural History. Some fossil and recent foraminifera.

ALFRED G. MAYER, Marine Laboratory, Carnegie Institution. Yacht and laboratory of the Carnegie Institution at Tortugas, Florida.

HUBERT LYMAN CLARK, Museum of Comparative Zoology, Harvard University. Echinoderms from Torres straits, Australia, with colored drawings and lithographs.

G. H. PARKER, Harvard University. The suction efficiency of a California sea-anemone.

W. T. BOVIE, Harvard University. Visible effects of Schumann rays on protoplasm. Effects of radium rays on permeability of protoplasm.

C. T. BRUES, Bussey Institution, Harvard University. Specimens and charts illustrating insects as carriers of infantile paralysis.

W. E. CASTLE, Bussey Institution, Harvard University. Examples of Mendelian inheritance, reversion and variety formation in rats and guinea-pigs.

FRANCIS G. BENEDICT, Nutrition Laboratory, Carnegie Institution. Respiration apparatus for animals.

T. B. OSBORNE, Connecticut Agricultural Station, and L. B. MENDEL, Sheffield Scientific School, Yale University. Photographs representing the growth of chickens fed with definite mixtures of food stuffs under laboratory conditions which have heretofore not led to success.

I. CHANDLER WALKER, Medical Service, Peter Bent Brigham Hospital. Proteid sensitization in relation to bronchial asthma.

H. S. WELLS, Medical Service, Peter Bent Brigham Hospital. Electrocardiography, or the application of the string galvanometer to the study of cardiac cases.

ALBERT A. GHOREYEB, Cancer Commission, Harvard University. Metal casts of heart and kidney blood vessels.

S. B. WOLBACH, Harvard Medical School. Studies in Rocky Mountain spotted fever.

HARVEY CUSHING AND W. M. BOOTHBY, Peter Bent Brigham Hospital. Apparatus of routine methods for clinical metabolism determinations.

E. W. GOODPASTURE, Peter Bent Brigham Hospital. An anatomical study of senescence, with especial reference to tumors.

E. E. TYZZER AND C. C. LITTLE, Harvard Medical School. The inheritance of susceptibility to transplanted tumor.

W. DUANE, Harvard Medical School. The technique of the preparation of radium for therapeutic purposes.

G. C. WHIPPLE, School for Health Officers, of Harvard University and Massachusetts Institute of Technology. Charts showing organization and membership of the school.

W. T. SEDGWICK, Massachusetts Institute of Technology. (1) Diagrams and tables illustrating the investigations of Professor Weston and Mr. Turner upon "The digestion of sewage effluents in an otherwise unpolluted stream." (2) An investigation of the behavior of certain species of bacteria in various materials between zero Centigrade and zero Fahrenheit. (3) A field investigation of the sanitary environment of a suburban population. (In room 10–411.)

S. C. PRESCOTT, Massachusetts Institute of Technology. Diseases of the banana in Central America and their control. (In room 10–411.)

ALFRED M. TOZZER, Peabody Museum, Harvard University. Race-mixture in Hawaii.

CHARLES PEABODY, Peabody Museum, Harvard University. Prehistoric specimens from caves of France and Palestine.

E. A. HOOTON, Peabody Museum, Harvard University. Casts and reconstruction of ancient man: skull of apes.

S. J. GUERNSEY, Peabody Museum, Harvard University. Cave explorations in northeastern Arizona.

ORIC BATES, Peabody Museum, Harvard University. Prehistoric Libyan remains.

THE NEW YORK MEETING OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

THE American Association for the Advancement of Science will hold its sixty-ninth meeting in New York City, from December 26 to December 30, 1916. This will be the fifteenth

of the convocation-week meetings and the first of the greater convocation-week meetings to be held hereafter once in four years, successively in New York, Chicago and Washington. When the association last met in New York, now ten years ago, there were about 5,000 members, the attendance was over 2,000, and there were nearly 1,000 papers on the programs. The membership of the association at present numbers about 11,000; the coming meeting will surely be the largest and most important gathering of scientific men hitherto held in this country or elsewhere. It has been planned that at these greater convocation-week meetings all the affiliated societies will join and this year there will be, including the sections of the association, more than fifty separate national bodies meeting together. Recent events have impressed on the general public the importance of science for modern civilization and national welfare and the responsibility of leadership has been placed on this country. It is consequently extremely desirable that scientific men make all possible efforts to be present at the meeting, which will be historic in the history of science and may serve in important ways to forward its advancement.

The registration headquarters will be at Earl Hall, Columbia University, and will be open on December 26, after 9 A.M. Most of the meetings of the sections of the association and of the national affiliated societies will be held at Columbia University. There will, however, be meetings at the American Museum of Natural History, at the City College, in the medical schools of the city and elsewhere, as may be arranged in the sections and by the societies. The council will meet at 9 o'clock on the morning of December 26, in the trustees' room, Columbia University, and will meet at the same time and at the same place daily during the meeting. The meeting of the general committee will be held at the hotel headquarters, the Hotel Belmont, at 9:30 on the evening of December 29. The Committee of One Hundred will meet at the Hotel Belmont at 2 o'clock on the afternoon of December 26. The several sections will hold their sessions for the nomination of officers and the transaction of other business on the call of the chairman, in most cases just before or just after the address of the retiring vice-president.

A complete program of the meeting, including the programs of the affiliated societies, will be ready on the morning of December 26 and will be given to members on registration. The reports on research work before the special societies will doubtless be more numerous than ever have been presented at a gathering of scientific men, and arrangements have been made for many programs of general interest and for social events, only part of which can be noted here.

The opening general session will be held at 8 o'clock on the evening of Tuesday, December 26, at the American Museum of Natural History. Dr. Charles R. Van Hise, president of the University of Wisconsin, will preside, and Dr. W. W. Campbell, director of the Lick Observatory, will give the address of the retiring president on "The Nebulæ." After the address there will be a reception by the president and the trustees of the museum.

Section A, Mathematics and Astronomy, will hold a general session, probably on Thursday. The address of Professor Armin O. Leuschner, of the University of California, will be on the "Derivation of Orbits." The American Mathematical Society, the Mathematical Association of America and the American Astronomical Society will meet in affiliation with the section.

Section B, Physics, will listen to the address of Professor Percival E. Lewis, of the University of California, on "Recent Progress on Spectroscopy," probably on Thursday evening. Papers in physics will be on the program of the American Physical Society, but there will be a general-interest session held jointly with Section C and the American Chemical Society. The Optical Society of America will meet in affiliation with the section.

Section C, Chemistry, will have as its vice-presidential address, "Asymmetric Syntheses and their Bearing upon the Doctrine of Vitalism," by Professor William McPherson, of the Ohio State University. Sections B and C, in conjunction with the American Chemical So-

ciety and the American Physical Society, will hold a joint session on "The Structure of Matter" on the morning and afternoon of Wednesday. These sessions will be held at the City College, which will provide luncheon and opportunity to inspect the buildings. On Thursday evening, at the American Museum of Natural History, Professor A. A. Noyes, of the Massachusetts Institute of Technology, will give one of the lectures complimentary to the citizens of the city on "The Production of Nitrogen." This lecture will be followed by a reception and a chemical exhibit. The American Electrochemical Society, as well as the American Chemical Society, will meet in affiliation with the section, and plans a symposium on "The Conduction of Electricity through Gases."

Section D, Engineering, will hold a session in the Engineering Societies Building, on the invitation of the United Engineering Society, the American Society of Civil Engineers, the American Institute of Mining Engineers, the American Society of Mechanical Engineers and the American Institute of Electrical Engineers. At this meeting Dr. Bion J. Arnold will give the address of the retiring chairman and there will be addresses by representatives of the engineering societies, followed by a reception to engineers and those working in sciences related to engineering. Section D will hold a joint session in the assembly hall of the Automobile Club of America, with the National Highways Association, the Automobile Club of America and the National Automobile Chamber of Commerce. There will also be joint sessions with the Society for the Promotion of Engineering Education and a session on sanitary engineering.

Section E, Geology and Geography, will meet on Tuesday and Wednesday, at Columbia University, when a special program by state geologists on the geology of their respective states will be presented. Owing to the death of Professor Charles S. Prosser, there will be no vice-presidential address. The Association of American Geographers will hold its meetings following those of the geologists. The address of the president, Professor Mark Jefferson, of the Michigan State Normal College, will be on "The Geographic Provinces of the United States." The American Alpine Club will meet at the New York Public Library on December 30.

Section F, Zoology, will hold its meetings with the American Society of Zoologists and the American Society of Naturalists. It is expected that Professor Vernon L. Kellogg, of Stanford University, will return from Europe in time to give the address of the retiring chairman. A dinner in honor of Professor E. B. Wilson, a past-president of the association, will be given at the Hotel Manhattan on Thursday evening, by his former students and colleagues. The Vertebrate Paleontologists will meet at the American Museum of Natural History on Thursday and Friday. The Entomological Society of America will meet on Tuesday and Wednesday, the address of the retiring president, Professor T. D. A. Cockerell, on "Fossil Insects," being given on the evening of the latter day. The American Association of Economic Entomologists will meet on Thursday, Friday and Saturday. There will be an address by the president, Dr. C. Gordon Hewitt, of the Dominion Experimental Farm at Ottawa. The entomologists will meet at Columbia University, with probably one session at the American Museum.

Section G, Botany, will hold a general-interest session on the afternoon of Wednesday, at which the address of Professor William A. Setchell, of the University of California, on "The Geographic Distribution of Modern Algæ," will be given. This will be followed by a symposium on the relations of chemistry to botany, opened by W. J. V. Osterhout and J. Arthur Harris. This is a joint session with the American Botanical Society, the American Phytopathological Society and the Ecological Society of America. Each of these societies will hold important programs. On Thursday there will be a joint session for the reading of invitation papers, at which the speakers will be William A. Murrill, Erwin F. Smith and W. A. Orton. In the evening a dinner for botanists will be given at the Hotel McAlpin, at which the address of Professor John M.

Coulter, the retiring president of the Botanical Society of America, on "Botany as a National Asset" will be given.

The American Society of Naturalists will meet on Friday. In the afternoon there will be a symposium on "Biology and National Existence," with papers by Stewart Paton, W. J. Spillman, Vernon L. Kellogg, Jacques Loeb and Edwin G. Conklin. After the dinner at the Hotel Manhattan in the evening Professor Raymond Pearl, of the Maine Experiment Station, will give the presidential address. The New York Zoological Society will entertain at the New York Aquarium the members of the Society of Naturalists and related societies on the evening of December 27. The American Eugenics Association will meet on Tuesday, Wednesday and Thursday, the address of the president, Dr. David Fairchild, of the United States Department of Agriculture, being on "The Importance of Photographs in Presenting Eugenic Discoveries." The Eugenics Research Association will hold a meeting under the presidency of Dr. Adolf Meyer, of the Johns Hopkins University.

Section H, Anthropology and Psychology, will refer special papers to the American Anthropological Association and the American Psychological Association. The address of the retiring chairman, Professor Lillien J. Martin, of Stanford University, will be on "Personality as revealed by the Content of Images." The American Anthropological Association, under the presidency of Dr. F. W. Hodge, of the Bureau of American Ethnology, will meet at the American Museum of Natural History, on Tuesday, Wednesday, Thursday and Friday. In affiliation with it will meet the American Folk Lore Society, the address of whose president, Dr. Robert H. Lowie, of the American Museum of Natural History, will be on "Oral Tradition and History." The American Psychological Association celebrates the twenty-fifth anniversary of its foundation on the afternoon of Friday. There will be historical papers by G. Stanley Hall, J. McKeen Cattell, Joseph Jastrow and John Dewey. The address of the president, Professor Raymond Dodge, of Wesleyan University, on "The Laws of Relative Fatigue," will be given on Wednesday evening at Columbia University, followed by a smoker. The annual dinner will be at the Hotel Marseilles. The association will hold a joint session with the section of education on Friday. The American Philosophical Association will meet at the Union Theological Seminary, adjacent to Columbia University, on December 26, 27 and 28. The address of the president will be given by Professor A. O. Lovejoy, Johns Hopkins University.

Section I, Economic Science, will listen to an address on "Scientific Efficiency and Industrial Museums, our Safeguards in Peace and War," by Dr. George F. Kunz, of New York. The programs of the section will be devoted to the metric system, to the national thrift movement, and to the effect of peace on our economical conditions. These sessions will be held at Columbia University. There will be a meeting concerning insurance on Friday afternoon in the Metropolitan Auditorium, Madison Square.

Section K, Physiology and Experimental Medicine, will meet at the American Museum of Natural History on Friday afternoon. Professor Frederic P. Gay, of the University of California, will make an address on "Specialists and Research in Medical Science" and there will be a symposium on "Cancer and its Control," taken part in by Gary N. Calkins, Leo Loeb, J. C. Bloodgood, James Ewing and E. C. Lakeman. This will be a joint meeting with the American Society of Bacteriologists. The Federation of American Societies for Experimental Biology, consisting of the American Physiological Society, the American Society of Biological Chemists, the American Society for Pharmacology and Experimental Therapeutics, and the American Society for Experimental Pathology will meet at the Cornell Medical College on Thursday, Friday and Saturday. There will be dinners on Thursday and Friday evening. The American Association of Anatomists will hold its meetings on Wednesday, Thursday and Friday, in the anatomical laboratories of three medical schools of the city, under the presidency of Professor Henry H. Donaldson, of the Wistar Institute.

Dr. Simon Flexner, director of the laboratories of the Rockefeller Institute for Medical Research, will give one of the public lectures before the association.

Section L, Education, will have, as the vice-presidential address, "Some Obstacles to Educational Progress," by Professor Ellwood G. Cubberley, of Stanford University. The section will meet on Wednesday, Thursday and Friday for discussion on educational tests and measurements, research problems and administrative problems. The American Nature Study Society and the School Garden Association of America are among the societies meeting with the association. The Society of Sigma Xi will hold its annual convention at Columbia University on the afternoon of Wednesday, with its dinner in the evening, at which there will be an address by the president, Dr. Charles S. Howe, president of the Case School of Applied Science. The American Association of University Professors will meet at Columbia University on Friday and Saturday, with a dinner at the Hotel Astor on Friday evening.

Section M, Agriculture, will meet on Tuesday and Wednesday. The address of the retiring vice-president, Dean Eugene Davenport, of the University of Illinois, will be on "The Outlook for Agricultural Science." This address, which will be delivered on the afternoon of December 27, will be followed by a symposium on the same subject, which will be taken part in by H. J. Wheeler, J. C. Lipman, G. F. Warren and B. Youngblood.

There will be a scientific exhibit and conversazione in University Hall, Columbia University, on the afternoons of Wednesday, Thursday and Friday, from twelve to six and probably on Wednesday evening from eight to ten. The demonstrations and exhibits before the separate societies will be made as usual, but in addition there will be gathered in one place exhibits showing the more important recent advances in the sciences in so far as they are of general interest. Scientific men will be present from four to six in the afternoon to explain and demonstrate the exhibits. It is hoped that the conversazione will not only be a convenient way for scientific men to inspect the work being done in different sciences, but will also enable them to meet their colleagues working in other departments.

Tea will be served by the Columbia University Ladies Committee in the Philosophical Building from four to six on the afternoons of Tuesday, Wednesday, Thursday and Friday. The Faculty Club of Columbia University will be open to men as a social center at these and at other times. The courtesies of the Chemists' Club (52 East 41st Street) are extended to members (men) for the days of the meeting. The Alumni Clubs of different universities and colleges and the Fraternity Houses, of which there are large numbers in New York City, will doubtless be glad to welcome their alumni. Luncheons may be obtained in the Columbia University Commons, the lunch room of Horace Mann School and the lunch room of Barnard College and in restaurants adjacent to the university.

The hotel headquarters will be the Hotel Belmont, which allows a discount to members on all rooms. It is situated opposite the Grand Central Station on 42d Street. This is also an express station of the subway by which Columbia University (Broadway and 116th St.) can be reached in about twelve minutes. The cars are marked Broadway or Dyckman Street; Lenox Avenue and Bronx Park cars are to be avoided. Other hotels have been selected as headquarters for some of the societies and sections. Thus the naturalists have selected the Manhattan; the zoologists the Astor; the botanists the McAlpin; the entomologists the Endicott; the anatomists the Martinique and the psychologists the Marseilles. Reservation of rooms should be made well in advance, as New York hotels are often completely full at this season of the year. The dormitories of Columbia University (for a limited number of men) and the dormitories of Barnard College and of Teachers College (for women) will be open for members at a cost of $1 a night. There are numerous boarding and lodging houses in the neighborhood of Columbia University which at the time of the meet-

ing will not be occupied by students and can be engaged by members.

The announcements here made are only those that have been reported well in advance and represent a small part of the programs. More than one thousand papers and addresses will be presented at the meeting, which will represent fully the advances of the natural, exact and applied sciences during the past year. There will, indeed, be so many simultaneous programs of interest that the difficulty will be to choose among them. A meeting of this size, however, will be held only once in four years, and the conflict is after all not so serious as if the meetings were held in different cities. A joint meeting of scientific men working in all fields gives opportunity for them to meet personally and to consult through committees and boards on means of promoting the advance of science by joint action. A meeting of such magnitude also serves to impress on the general public the strength which science has attained in this country, and the need of supporting scientific research for the welfare of the nation.

SCIENTIFIC NOTES AND NEWS

THE John Fritz medal was awarded in January, 1916, to Dr. Elihu Thomson, for "Achievements in Electrical Inventions, in Electrical Engineering, in Industrial Development and in Scientific Research." We learn from the *Electrical World* that the medal will be presented to Dr. Thomson at a meeting to be held in Boston on Friday evening, December 8. The presentation will take place in the Central Lecture Hall of the new buildings of the Massachusetts Institute of Technology. The program of the evening will include addresses by John J. Carty, chairman of the presentation committee of the board of award; E. W. Rice, Jr., president of the General Electric Company, and Dr. Richard C. Maclaurin, president of the Massachusetts Institute of Technology. The presentation will be made by Dr. Charles Warren Hunt, and the ceremonies will conclude with the response of Dr. Thomson. The John Fritz medal is awarded from time to time for notable scientific or industrial achievement, and was provided for in a fund subscribed in memory of the great engineering pioneer, John Fritz. The award of the medal is made by a permanent board composed of four members from each of four American national engineering societies, namely, the American Society of Civil Engineers, the American Society of Mechanical Engineers, the American Institute of Mining Engineers and the American Institute of Electrical Engineers. The members of the 1916 board are: Representing the civil engineers—Charles Warren Hunt, John A. Ockerson, George F. Swain, Charles D. Marx; representing the mechanical engineers—John R. Freeman, Ambrose Swasey, John A. Brashear, Frederick R. Hutton; representing the mining engineers—Albert Sauveur, E. Gybbon Spilsbury, Charles F. Rand, Christopher R. Corning; representing the electrical engineers—Ralph D. Mershon, C. O. Mailloux, Paul M. Lincoln, John J. Carty.

THE trustees of Cornell University have accepted the resignation of George Sylvanus Moler, professor of physics, to take effect in June, 1917. Professor Moler will retire from teaching, having reached the age limit. The board placed upon its minutes the following resolution:

Resolved, that the trustees in accepting the resignation of Professor Moler desire to express their high appreciation of his faithful and devoted service to the university in the department of physics for over forty years. As a teacher he is held in affectionate and grateful remembrance by many generations of university students. For twelve years he shared with Professor Anthony the entire work of the department and during that period in collaboration with him designed, constructed and installed the first dynamo in America, the first arc-lighting system (that on the campus of Cornell University), and the first apparatus for the electrolytic production on a considerable scale of oxygen and hydrogen. He has also devised countless original and ingenious pieces of apparatus of incalculable value to the department of physics. And the photographic laboratory in Rockefeller Hall, with its original and unique equipment, is largely of his planning.

DR. R. A. MILLIKAN, professor of physics in the University of Chicago, has been appointed Hitchcock lecturer at the University of California for 1917, and will give a series of lectures at Berkeley, beginning about February 1. Among the Hitchcock lecturers of recent years at the University of California have been Thomas Hunt Morgan, professor of zoology in Columbia University; Henry Fairfield Osborn, research professor of zoology in Columbia University; Dr. A. D. Waller, director of the physical laboratory of the University of London; Julius Steiglitz, professor of chemistry in the University of Chicago; Harry Fielding Reid, professor of dynamical geology and geography in the Johns Hopkins University, and Dr. Richard M. Pearce, professor of research medicine in the University of Pennsylvania.

DR. FRANK D. ADAMS, Logan professor of geology and dean of the faculty of applied science, McGill University, has just completed a course of six lectures on pre-Cambrian stratigraphy for the department of geology, Columbia University.

DR. CARLOS CHAGAS, of the Institute for Experimental Pathology at Rio de Janeiro, has been invited to conduct a course on tropical medicine at Harvard University.

THE vice-chancellor of Cambridge University has appointed Mr. R. T. Glazebrook, C.B., fellow of Trinity College, director of the National Physical Laboratory, to the office of reader on Sir Robert Rede's foundation for the ensuing year.

AT a recent general meeting of the members of the Royal Institution, Dr. H. E. Armstrong, F.R.S., was elected a manager, in place of the late Professor Sylvanus P. Thompson. A resolution of condolence with the relatives of the late Sir Victor Horsley, a member of the Royal Institution, was passed.

A CORRESPONDENT informs us that Dr. H. B. Fantham, of the Liverpool School of Tropical Medicine, who was appointed to the post of chief protozoologist to the forces of the Allies at Salonika, has been seriously ill with amœbic dysentery and is at present convalescing—but on duty—at Malta.

WE learn from *Nature* that Major T. Edgeworth David, professor of geology in the University of Sydney, has recovered from the effects of serious injuries received while conducting mining operations in northern France, and hopes shortly to rejoin his regiment.

PROFESSOR G. CAREY FOSTER, a past president of the Institution of Electrical Engineers, has been elected by the council an honorary member of the institution.

AFTER forty-five years' service Dr. C. Ritsema, keeper of the entomological collections of the State Museum of Natural History at Leyden, has retired. He is succeeded by R. van Eecke.

DR. WM. H. WESTON has resigned his position as instructor in biology in charge of the botanical work at Western Reserve University to accept a position as a pathological inspector of the Federal Horticultural Board. He will be stationed at Washington, D. C.

DR. ERIC MJOBERG, a Swedish explorer, who arrived in New York on November 22, said, as reported in daily papers, he had come to the United States to study the latest inventions in aviation preparatory to making arrangements for an exploration trip into the interior of New Guinea.

AT the meeting of the Section of Medical History of the College of Physicians of Philadelphia, on November 21, Dr. Arnold C. Klebs, Washington, D. C., read a paper on "Some Recent Results of Paleopathologic Research."

DR. J. PAUL GOODE, professor of geography at the University of Chicago, recently gave a lecture before the Civic and Commerce Association of Minneapolis on the "Geographic and Economic Foundation of the Great War."

AT the two hundred and twenty-sixth meeting of the Elisha Mitchell Scientific Society, held at the University of North Carolina on November 14, the papers were: Dr. W. C. Coker, "Some Problems in Classification"; Mr. T. F. Hickerson, "The Quebec Bridge."

THE municipal and university authorities of Barcelona recently placed a marble memorial

tablet on the house at Castellersol where had been born Dr. M. Fargas Roca, professor of obstetrics and gynecology at the University of Barcelona, and senator of the realm. After this ceremony the procession passed to the city hall, where his portrait was installed.

Dr. Francis J. Keany, trustee of the Boston City Hospital, and professor of dermatology at Tufts Medical School, died on November 23, at the age of fifty years.

Dr. Henry Gunder, formerly professor of mathematics at Findlay College, Ohio, and later at Little Rock University, Arkansas, died on November 20, at the age of seventy-nine years.

James S. Duff, of Toronto, minister of agriculture for Ontario, died on November 17, at the age of sixty years.

Dr. Oskar Backlund, the eminent director of the Imperial Observatory at Pulkova, Russia, died on August 29. He was in his seventy-first year and had been the director of the Pulkova Observatory since 1893.

Emeritus Professor John Ferguson, who last year resigned the regius chair of chemistry in the University of Glasgow, which he had held since 1874, died on November 3, aged seventy-nine years. In addition to his work in chemistry he was a well-known archeologist.

Professor H. M. Waynforth, professor of engineering, King's College, University of London, died on November 5, at the age of forty-nine years.

Professor H. H. W. Pearson, professor of botany in the South African College, died at Mount Royal Hospital, Wynberg, on November 3. The London *Times* says: "His death is a great loss to botanical science, in which he had a European reputation, particularly by his discovery of missing links in evolutionary botany. His death is felt with peculiar intensity in South Africa, where Mr. Pearson's professional enthusiasm and keen perception of scientific possibilities were mainly responsible for the establishment a few years ago of the Kirstenbosch Botanic Gardens, which on the testimony of the director of Kew is likely to become one of the most valuable, economically and scientifically, in the world."

Nature reports the death of Lance-Corporal J. W. Hart, who, having volunteered in the early days of the war, was killed on September 15. At the beginning of the war he held the post of horticultural assistant at Bedford College, London, and was in charge of the botanical garden, the successful development of which was largely due to his skill and energy. The death is also reported of Lieutenant John Handyside, who fell in one of the recent advances on the Somme, at the age of thirty-five; he was a distinguished graduate of Edinburgh and Oxford, and since 1912 had been lecturer in philosophy in the University of Liverpool.

A clipping sent us from a Munich newspaper reads: "Dr. Oskar Piloty, professor of chemistry at Munich, son of the distinguished painter, lost his eldest son in battle. In order to avenge his death, the father of his own accord joined the army in France, and he too has now been killed."

After conference with many of the vertebrate and invertebrate paleontologists in different parts of the country it has been deemed wise for the vertebrate paleontologists to meet in the State Museum, Albany, Wednesday, December 27 in company with the geologists and invertebrate paleontologists. On Thursday and Friday, December 28 and 29, an adjourned meeting of the Vertebrate Paleontologists will be held in the American Museum of Natural History, New York, at hours to be announced later. Members are invited to send immediately titles of papers or discussions directly to Dr. W. D. Matthew, acting secretary of the Vertebrate Paleontological Section. Arrangements will be made for a reunion dinner on Friday evening, December 29.

The Association of American Agricultural Colleges and Experiment Stations met at the new Willard Hotel, Washington, D. C., on November 15, 16 and 17.

The fifteenth anniversary of the Ohio Society of Mechanical, Electrical and Steam Engineers was celebrated in its thirty-fourth meeting, which was held on the campus of the

Ohio State University, November 16. Among the speakers were Professor Horace Judd and Professor F. W. Marquis, both of the department of mechanical engineering of this university.

The Electrical World states that this year America's Electrical Week will be inaugurated by the first permanent flood-lighting of the Statue of Liberty on the evening of December 2. President Wilson and a distinguished gathering of diplomats and industrial leaders will officiate at a program of ceremonies starting in lower New York harbor and concluding at a banquet to the nation's executive in the Waldorf-Astoria Hotel. Mayor Mitchel, of New York City, has named a committee of some two hundred representative men in the electrical industry and in business and civic life, who will escort President Wilson and his party during the inaugural. A committee on arrangement has charge of an electric vehicle parade starting from the Battery and passing up Broadway to Lafayette Street, over Fifth Avenue to the Waldorf-Astoria Hotel. The official ceremony of rededicating the statue will take place at the Waldorf-Astoria Hotel. Ambassador Jusserand, who will present a special message from the President of France, and ex-Senator Chauncey M. Depew, who delivered the main oration of the statue thirty years ago on October 28, will deliver orations, to which it is expected the President will reply briefly.

A government investigation of industrial fatigue by physiologic methods has just been made by Dr. Stanley Kent, the physiologist, and is summarized in the *Journal of the American Medical Association*. The report is divided into three sections. The first deals with fatigue as a result of overtime. It is stated that when the week-end rest is suspended, fatigue will persist; residual fatigue resulting from inadequate rest leads to lowered efficiency and lessened output. Overtime periods worked on consecutive days produce more fatigue than if separated by days of ordinary length. Overtime induces more fatigue late in the week than it does early in the week. Overtime is physiologically and economically extravagant. It frequently fails in achieving its object, as the following case shows: A girl in one of the works frequently did not attend during overtime. She also habitually began work at 8:30 instead of 6 A.M. Thus she usually worked only eight hours a day, instead of twelve. When asked the reason, she replied that the extra rest enabled her to work so much more quickly that she was able easily to make up for the lost time. The second section of the report deals with the influence of fatigue and of overtime on output. The total daily output may be diminished by the introduction of overtime, for the rate of working and total output are limited by fatigue rather than by other conditions. A group of piece workers increased their earnings considerably as a result of a diminution in the length of the working day. In the third section it is stated that the total output of a factory is a question of adjustment of the factors concerned, the principal of these being the actual time worked and the actual rate of working. Reduction of the latter will soon counterbalance increase of the former, and thus overtime frequently leads to a diminution of total output. The health of the worker, on which his rate of working and his endurance depends, is prejudiced by overtime and to a less extent by work in the early morning hours. The suspension of overtime was followed in every case by an improvement in conditions of the worker, and was found to effect a saving of 4.5 per cent. The experiments on which the foregoing conclusions are based were carried out with great care and by means of all kinds of ingenious apparatus for testing attention and working power. Both male and female labor was employed in the factories concerned. Dr. Kent also points out that the evidence is against Sunday labor, which is liable to prove "disastrous." As a result, the minister of munitions has stopped all Sunday work in the factories producing munitions.

In a lecture before the Royal Society of Arts on November 3, Professor William Stirling, of the University of Manchester, said that the insatiable demand for shells, guns and other munitions of war had made the problem of industrial fatigue suddenly acute. The problem to be solved, and it was being solved,

was to ensure the maximum of output with the minimum of fatigue. Overtime was an elastic term, and not only imposed a severe strain on the worker, but it curtailed unduly the periods for rest and repose; it was uneconomical, physiologically extravagant, and frequently resulted in lost time and diminished output.

UNIVERSITY AND EDUCATIONAL NEWS

The University of Chicago has received from Mr. Frederick H. Rawson a gift of $300,000 for the construction of a laboratory building in connection with the plans for the medical school.

A provisional gift of $100,000 to the University of Vermont has been given by General Rush C. Hawkins, of New York. The money is given on condition that the university raise an additional $200,000.

Tulane University has received a bequest of $60,000 for the School of Tropical Medicine, available after the decease of the wife of the late Colonel W. G. Vincent.

The new gymnasium of the Stevens Institute of Technology was dedicated with appropriate ceremonies on November 18. The building, which was erected at a cost of over $125,000, is the gift of Mr. William Hall Walker, of New York.

Dr. L. V. Heilbrun has been appointed instructor in microscopic anatomy at the College of Medicine at the University of Illinois.

The School of Medicine of the University of Alabama announces that two new all-time professors have been appointed to the faculty. Dr. Joseph M. Thüringer, of the Harvard Medical School, becomes head of the department of anatomy, and Dr. Claude W. Mitchell, Ph.D. (Nebraska, '13), M.D. (Chicago, '15), head of the department of physiology and pharmacology.

Mr. William George Palmer, B.A., formerly scholar, has been elected to a fellowship at St. John's College, Cambridge. Mr. Palmer, who came up from Guildford Grammar School, took a first in each part of the Natural Science Tripos, 1913–14, with distinction in chemistry, and was awarded the Hutchinson studentship.

DISCUSSION AND CORRESPONDENCE

SYNCHRONISM IN THE RHYTHMIC ACTIVITIES OF ANIMALS

Two men walking together keep step so easily that the keeping step seems automatic. With a similar feeling of its naturalness we keep time in various ways, as in marching or dancing to music. Although these actions seem so automatic, they all or nearly all were learned by conceptual awareness of the relations between one's own actions and the actions of others, and purposive imitation of the latter. Such awareness of relations and purposeful imitation have not been found in animals (with the possible exception of the Primates). Certainly in most of the behavior of animals the tendency to keep time with an external rhythm is conspicuously absent. When two horses are driven abreast, each trots in his own rhythm in sublime disregard of his team-mate. Every circus has its so-called dancing animals, but I never saw one that really kept time with the music except as the trainer prompted it. Some birds have wonderful musical powers, but I never knew of a case of two birds singing in unison, nor of a bird singing synchronously with any external rhythm.

Nevertheless, although an animal can not have a concept of the relation between two coinciding rhythms, it is supposable that some animals might have an innate mechanism that would bring them into synchronism with an external rhythm, just as two pendulums or two dynamos, if properly adjusted, maintain a perfect synchronism. Let us review the observations that might substantiate such a supposition.

Many animals are provided with lock and key reflexes which produce an admirable synchronism. Two cocks fighting jump at each other at almost the same moment. Many birds, notably some of the Limicolæ, fly in close flocks and the whole flock turn apparently at the same moment in their rapid evolutions. But it is important to notice that these actions are not rhythmical. To maintain such admirable synchronism and at the

same time maintain a rhythm would be a quite different task.

There are some cases in which animals do act in synchronism with an external rhythm, but so far as I have observed they are always cases in which the time of the animal's actions is regulated by a powerful force from the environment, and fall under one of the two following heads: (1) Slow rhythms, such as those of the seasons, or of day and night, in which there are changes in temperature, light, etc., which have plenty of time to act on the organism; (2) cases in which there is bodily contact between the organism and that with which it keeps in synchronism, as the case of a canary swinging on a swing-perch, or that of certain spiders swinging on their webs. Are there any cases which do not fall under either of these two heads? Some observers have reported them, but let us examine their reports.

Dr. Edward S. Morse[1] cites a case from memory in which he saw "fireflies flashing in unison," but he gives no exact details. He quotes a paper by Mr. Blair[2] mentioning the same phenomenon; but Mr. Blair states that he never observed the synchronism himself, and he does not cite any authority who has observed it. Dr. Morse in another paper[3] quotes R. Shelford as observing a tree full of fireflies pulsating "so that at one moment the tree would be one blaze of light, whilst at another *the light would be dim and uncertain.*"[4] This last clause makes it appear that some fireflies were not in synchronism with the others, and thus brings in the statistical fallacy to be mentioned presently. Dr. Morse quotes Dr. H. C. Bumpus as another observer of the phenomenon; I wrote to Dr. Bumpus, asking certain questions, and he kindly sent me the following statements as to his observation: he saw the synchronism in perhaps 50 fireflies distributed over two acres; he noticed the synchronism only as he was passing the area, so can not say how long it lasted; the interval between flashes was perhaps a half second; he thinks the synchronism was not accidental and not an illusion; but he thinks there were also *some fireflies that were flashing asynchronously.*[4] Now, where a large number of fireflies are flashing at slightly differing rates there must be a great amount of accidental synchronism; to determine whether there is a degree of synchronism not due to mere accident, one would need a statistical examination. Viewing any large assortment of instances without statistical methods, one can see in them whatever one is predisposed to see; and we are always predisposed to perceive a rhythm—this is a well-known psychological fact. I once had an experience which I think was like that with the fireflies: I was looking at a great area of water covered with ripples flashing in the sunlight, and the flashes I saw were all synchronous, at a rate of perhaps three per second; but their synchronism must have been an illusion.

Dr. Morse[5] quotes a different case, from Cox, who says:

> Certain ants . . . when alarmed, knock their heads against the leaves and dead sticks . . . every member of the community makes the necessary movement at the same time.

This case would seem to necessitate that the ants perceive time relations, for each ant must know when the sound is to come and must anticipate it by making the head movement. It is much more probable that the synchronism was an illusion of the observer.

Professor W. B. Barrows[6] reports seeing a bittern sway gently from side to side as the grass around it was swayed by the wind. But it is doubtful if the observer, seeing the bird against a moving background, could tell truly whether it swayed or not. The details which are given make the phenomenon seem very like an illusion.

In 1897, Dolbear[7] stated that all the crickets in a given field chirp simultaneously. But

[1] Morse, E. S., Science, February 4, 1916, 169–170.

[2] Blair, K. G., *Nature*, December 9, 1915, 414.

[3] Morse, E. S., Science, September 15, 1916, 387–388.

[4] Italics mine.

[5] Morse, E. S., *loc. cit.*, 387.

[6] Barrows, W. B., *The Auk*, April, 1913, 187–190.

[7] Dolbear, A. E., *American Naturalist*, Vol. 31, 970–971.

Professor Shull[8] observed more carefully, found that this was not the case, and concluded that the synchronism observed by Dolbear was an illusion. However, Shull observed certain cases in which two individuals were in synchronism. His observations are not open to the objections raised in case of the fireflies, because: first, there being only two crickets concerned, the statistical fallacy does not enter; secondly, his observations were repeated and checked with great care, the rate of chirping being accurately timed. There can be no doubt that Shull observed real synchronism between two crickets at a time. But he says (in a letter to me, dated October 8, 1916):

> I am at present inclined to think that these cases of synchronism were usually accidental. . . . However, the insects do, I am sure, influence one another. . . . I regard it as still an open question whether something more than chance was involved.

In the article quoted, he questions whether the synchronism may have been due merely to temperature; for at a given temperature nearly all the crickets chirp at almost exactly the same rate.

In answer to our question whether animals ever do maintain a synchronic rhythm of a sort not included under (1) and (2) of my fourth paragraph, we have found good evidence for an affirmative answer only in the case of crickets chirping. And in that case it is still somewhat in doubt whether their simultaneity is accidental, or due to the influence of environment, or due to a lock and key adaptation by which one cricket stimulates the other. If any naturalist can give complete and accurate observations on such synchronic rhythms, these will be of great interest to the psychologist.

Wallace Craig

University of Maine

[8] Shull, A. F., The Stridulation of the Snowy Tree-cricket (*Œcanthus niveus*), *Canadian Entomologist*, 1907, Vol. 39, 213–225.

IS CUCUMBER MOSAIC CARRIED BY SEED?

In 1915 cucumber mosaic caused a rather serious loss on one of the farms where cold frame cucumbers are grown in the tidewater section of Virginia. The same disease again developed on this farm in the spring of 1916 on land which was in cucumbers last year and also on land which had not grown this crop for the past three years. This year as usual the seed was sown in pots in the greenhouse and the plants were transplanted to the cold frames on April 5, 1916.

On May 25, 1916, before the glass covering had been removed from the cold frames, the writer observed typical mosaic plants scattered throughout the frames. A little later "white pickle" fruits were also obtained from the diseased vines. Of a total of 7,785 plants 110 were diseased on the above date.

The cold frame growers in this section all use one strain of forcing-cucumber seed which they obtain from the same seed company. On visiting the other cold frame farms during the same week typical cases of mosaic were found on three of the five farms and plants suspected of the disease were observed on the other two. Plants on one of the latter two farms have since produced typical "white pickle" fruits though the leaves are not strikingly mottled.

These observations indicated that the disease was carried by the seed, but as in some cases the diseased plants were growing on land which had produced mosaic plants the previous season, there remained the possibility of a soil factor.

Data which made the matter of soil transmission appear less likely was obtained from cucumber plants which the writer was growing at the Virginia Truck Experiment Station. These plants were from the same strain of seed as that used by all of the cold frame growers. The seed was planted April 27, 1916, in a cold frame of steam sterilized soil which had not previously grown a crop of cucumbers. Of a total of 155 plants 58 typical mosaic plants were observed on June 5, 1916. No insects were observed on the plants up to that time, probably due to the fact that the bed is surrounded on three sides by a tall hedge and on the fourth side by the station greenhouses. The high percentage of diseased plants and the failure to account for the disease in any other way lead the writer to think that this mosaic came from the seed.

Further confirmatory data relative to seed transmission has since been obtained from seed which the writer saved from typical "white pickle" cucumbers collected during the season of 1915. Unfortunately a large per cent. of the seed thus obtained was destroyed by mice. From the small amount which remained eleven typical mosaic plants have been obtained. These plants first showed mosaic in the second or third true leaves, and have since produced typical "white pickle" fruits. The plants were started in pots of steam sterilized soil and transplanted to a field which had not previously grown cucumbers. At the time the disease was first observed on these plants no cucurbits were growing nearby and no insects had been seen on the plants. It seems advisable to present these observations as indicating another means of primary dissemination of cucumber mosaic.

J. A. McCLINTOCK
VIRGINIA TRUCK EXPERIMENT STATION,
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THE CULTURE OF PRE-COLUMBIAN AMERICA

TO THE EDITOR OF SCIENCE: In common doubtless with many of your readers I noted with interest the short sketch by Professor Grafton Elliot Smith of his views regarding the migration of culture to the American continent. I also awaited with some expectation of assurance an unveiled hostility, which has now appeared in your columns of the issue of October 13, under the signature of Dr. Goldenweiser and Mr. Means.

From the nature of circumstances it must be some weeks before my former chief can reply to these gentlemen and I would request, therefore, in the meantime the opportunity to make a few suggestions.

Apart altogether from the confession of Dr. Goldenweiser, it is of course obvious from their arguments that both writers have arisen in opposition and committed themselves in your columns without having informed themselves of Professor Elliot Smith's precise statements and method of handling his mass of accumulated evidence.

From a somewhat misleading footnote in your issue of August 11 it would seem that "The Significance of the Geographical Distribution of the Practise of Mummification" had as yet to be published. This monograph appeared in the *Memoirs* of the Manchester Literary and Philosophic Society on July 7, 1915, and was published in book form under title "The Migrations of Culture" a few weeks later. But together with the succession of ensuing papers in that journal and in the *John Rylands Bulletin*, this important monograph seems entirely to have escaped the attention of your contributors. That this should be so in the maze of present-day literature is entirely forgivable, but it is amazing that in "awaiting with the greatest interest and impatience" further exposition of Elliot Smith's brilliant work, ethnologists should hasten with such unseemly speed to warn him against encroaching upon a theory which by the assertion of Dr. Goldenweiser himself must forever rest upon the uncertain basis of mere negative evidence, a theory which to some of us in the light of modern exactitude of method seems scarcely defensible.

Dr. Goldenweiser would have us prove every step of the way in the diffusion theory, and rightly so. In the chaos of ethnological observations, many of them afforded by amateur or untrained investigators, and by indifferent methods, too much stress can not be laid upon this. But at the same time are we really to accept for any particular custom the assertion of independent development merely because as yet rigorous proof of diffusion is not forthcoming! Professor Elliot Smith simply contends that we should subject both to the most searching investigation. Contrary to Dr. Goldenweiser's suggestion, it is not loosely claimed that sometime, somehow, diffusion has occurred. Such statements as have been made are accompanied by tangible evidence of their accuracy. The excellent and indisputable researches of Professor G. A. Reisner and Dr. Elliot Smith in Egyptian archeology afford a striking example of the care and vigor with which every shred of evidence is scrutinized. In the work of the two investigators just mentioned on the discovery of the use of copper and the evolution of the rock cut tomb and in

the distribution of these arts the same searching technique is perceptible and the complete reconstruction of the historic event which Dr. Goldenweiser justly demands is already forthcoming. Especially is it to be observed that this is the case in the assertion of independent development in Egypt of both these practises, a proof, the possibility of which Dr. Goldenweiser apparently denies. But indeed if, as on Dr. Goldenweiser's own statement, all the proof that we have is in favor of diffusion, may we not at least with equal right transpose one of his sentences and say, "In all cases diffusion must be assumed until independent development is proved or, at least, made overwhelmingly probable"?

If such striking similarities, parallelisms, convergences in the working of the human mind really do occur, why, in the words of Mr. Means, should there be no such thing as a wheeled vehicle in all pre-Columbian America? Mr. Means's difficulties over wheels and ships are precisely those which the supporters of independent development should hasten to explain. As a matter of fact, as most recently Dr. Rivers has demonstrated, it is the useful art which frequently is lost in the spread of culture. The human mind is not the logically working instrument, leaping at once to full conception of the connection between cause and effect, between possibility and use, which we are invited to assume. In the geographical distribution of culture whatever has been merely useful tends to disappear; whatever is bound to the consciousness of the individual through some link of superstition or religion tends to be retained, though its significance may be misunderstood or indeed even reversed.

It is true, as Mr. Means hints, that so far no comprehensive and detailed analysis has been made of the physical anthropology of the American peoples comparable with that undertaken by Professor Elliot Smith and his associates upon the ancient Egyptians. It is to be hoped that we may be able to make the lack good in time. But the impress left upon the features and the impetus given to the arts and crafts alike of the ancient Egyptians by the immigration of alien peoples leads me to suspect that in the bodies of the pre-Columbian Americans themselves we may ultimately find the corroborative evidence of whence American culture came. It may well be that by this method we shall find the arrows in Dr. Elliot Smith's figure correctly placed. But even if, as in fact Professor Elliot Smith believes, inherent difficulties in the work will prevent physical anthropological studies in America from bearing the conclusive results obtained from similar researches in Egypt, the case for diffusion, contrary to Mr. Means's conception, is not thereby weakened. In the sturdy nature of its composition the culture-complex is amply strong enough to stand by itself and the possibility that some avenues of approach are closed to us does not necessarily prevent our arrival at definite conclusions along those which are plainly open. Critical ethnologists will, I am sure, judge from the facts themselves.

In conclusion, like one of your contributors, I await with impatience a further monograph from Professor Elliot Smith's fascinating and compelling pen; a monograph which I hear from other sources is to be entitled "The Ancient Mariners."

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MOSQUITOES AND MAN AGAIN

Without continuing the discussion further than the limits of this paper, it seems advisable to state once more the contention made in my paper "Mosquitoes and Man"[1] for Mr. Jennings in his rather elaborate and erudite criticism[2] of it misses the whole point so completely as to be definitely surprising and almost amusing.

The point was not the "association" of mosquitoes with man, but that the malarial mosquito *followed* man, and while following man is included in the association with man, it is nevertheless a specific point and worthy of some attention.

[1] Science, June 2, 1916.
[2] Science, August 11, 1916.

Major Ashburn's observations were, that in a given place, men and mosquitoes being associated, on the removal of the human element the malarial mosquitoes no longer bred in that locality as before, the larvæ from being numerous became rare, almost, if not quite absent. An instance of this occurred at Miraflores, formerly a hot-bed of malaria, and where *Anopheles albimanus* bred in abundance. When, in connection with the Canal work, the inhabitants were removed, it was presently discovered that although the breeding conditions were quite as good, *A. albimanus* was no longer breeding in that locality as before, the larvæ having become *very* rare. Contrariwise, that when camps were established in new localities where malarial mosquitoes and their larvæ were rare or unknown, both adults and larvæ presently appeared in greatly increased numbers, and this was followed by a malarial outbreak among the men. Major Ashburn has records of some ninety instances where these conditions, in connection with the establishment and abandonment of construction camps, occurred, and it was on this large number of cases that he based his conclusions.

The question of an "animal barrier" is not a question of whether any given mosquito will attack a horse or a cow or a dog, but whether such animals will prove a protective barrier, against the malarial mosquitoes, for human beings living beyond. Whether disease-bearing mosquitoes will breed except near human habitations is another question, and apparently has several factors, so that it is quite possible that it can not be answered by a general statement. However it is quite certain that these mosquitoes would not have become "disease-bearing" if they had not bred near habitations and been in close touch with man.

The experience of many sanitarians has been that, under usual conditions, to keep the breeding places of malarial carriers at a distance of "four hundred yards" is sufficient to protect the inhabitants of a locality from malaria, and Watson shows that the outer coolie lines are at least the only ones attacked under these conditions. This can only mean that the malarial mosquitoes do actually breed near, and not, as Mr. Jennings suggests, "at a distance from human habitations." Also of course this implies the intimate association of malarial mosquitoes and man, and there is nothing in my paper to indicate a lack of recognition of that general condition. It called attention to an entirely new viewpoint, and one that gives a valid reason not only for the usually accepted limit of flight, but to Dr. Watson's observations concerning the outer coolie lines, and even for the long flight recorded at Ancon, while it suggests a hitherto little recognized need of the protection of human beings in the formation of new camps in heretofore uninhabited sections where no malaria has been known, or where the larvæ of malarial mosquitoes are extremely rare or unknown.

It is hardly permissible to assume ignorance, on the part of a Medical Officer and a worker in preventive medicine, of the literature and labors of many investigators whose work was based on the, at least implied, "association" of mosquitoes and man. Even the average layman knows the story of Manson's suggestion to Ross. Especially is such an assumption out of place in regard to Major Ashburn, whose work on the transmission of disease by insects, carried on in the Philippines as a member of the "Board for the Study of Tropical Diseases" is widely known and accepted as one of the authorities on the subject.

It is always better to keep "an open mind" on every subject, scientific or otherwise, and certainly to avoid unfair comments on other workers. There is work enough for all, and the various phases of the study of disease are so complicated as to give every part of the subject many sides, and many points of contact with the labors of special investigators in other branches. That the whole may develop in a well-balanced and scientifically correct fashion requires harmonious interrelation between these various workers, and a just recognition of the viewpoints of others. Mr. Jennings's connection with the work in the investigations in the Canal Zone should have broad-

ened him sufficiently to have made other attitude and action impossible. C. S. LUDLOW

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WASHINGTON, D. C.,
September 29, 1916

THE SONG OF FOWLER'S TOAD (BUFO FOWLERI PUTNAM)

IN SCIENCE for September 29, Mr. H. A. Allard states that for some years he has heard at Clarendon, Va., two types of toad cries. One was uttered early in the spring, "a steady, trilling monotone," lasting "from 10 to 20 seconds," and "resembling the song of *Bufo americanus* as it is heard in New England." The other was that of Fowler's toad, "the unmistakable, weird, wailing scream which advertises its presence throughout its range." He further states that on May 2, 1916, he caught toads uttering the former note, and found them to be *Bufo fowleri*. He presented them to the National Museum, where they are under accession number 59692.

Now I have collected for some years in the region in question, as my home is in Alexandria, and I have found both *B. fowleri* and *B. americanus* fairly common, although *fowleri* seems the more abundant. I have studied the breeding habits of these toads at Haverford, Pa., where both occur very commonly and are quite distinct.

Americanus is one of the first Anura to appear in the spring; *fowleri* one of the last. Transformed *americanus* are sometimes met with before *fowleri* begins to sing. The note of *fowleri* there is always the short snoring scream. The note of *americanus* is always much longer, although its trill and its softness are somewhat dependent on whether the toad is on land or in the water. I have collected *fowleri* in numbers at Brevard, N. C., at an altitude of 2,200 feet. The note there was the same which I have heard at Alexandria and at Haverford.

Finally, during the first part of September, I was working in the reptile and amphibian department of the National Museum, and while looking over the catalogue I chanced to see there an entry of *B. fowleri* with the remark that the note was that of *B. americanus*. My interest aroused by this and also by the fact that they were local specimens, I looked them up and examined them. I soon came to the conclusion that they were not *fowleri* at all, but *americanus*. They were much too large for *fowleri*, and they had large warts arranged singly in spots as in *B. americanus*, instead of the small warts, three to five in a spot as in *B. fowleri*. These toads were catalogue number 59692, and were collected by Mr. Allard at Vinson Station, Va., on May 2, 1916. Mr. Allard was probably misled by the fact that they did not have the deeply spotted breast of most *americanus*, but this is not too reliable a character, as some *B. fowleri* have speckled breasts and some *B. americanus* have, as in this instance, immaculate breasts.

Thus there is no reason to believe that Fowler's toad has two distinct notes, and confidence can still be reposed in the calls of toads and frogs as differentiating characters.

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SCIENTIFIC BOOKS

Morphology of Invertebrate Types. By ALEXANDER PETRUNKEVITCH. The Macmillan Company, New York. 1916.

Under this title Professor Petrunkevitch offers us a laboratory guide for representative invertebrate types and, in addition, material of the sort commonly found in our textbooks. "Each chapter consists of two parts: a monograph in which a description is given of the animal selected as representative of its class and instructions for the students to follow in dissection." The purpose of the former is to give the student an account of the morphology of his type form to which he may refer throughout his dissection and to give the teacher more freedom, since the lectures are thus relieved of much detail. The book is frankly morphological, as its name implies, and the author makes no apology for this; but rather contends in his preface that the student who aspires to the work of experimental zoology is often hampered by "a superficial knowledge of the structure, life and development of those very animals which in his later studies

he is going to use for experiments." The book is written not for the elementary course in invertebrate zoology, which is sometimes offered as a part or the whole of a course in general zoology, but for third and fourth year undergraduates who are presumed to have completed one or more courses in zoology. It is the outcome of a course in which its author attempts to give students, who desire more zoology either from general or professional interest, a foundational knowledge of invertebrate morphology, and very wisely he makes no attempt to overload a large subject with the many other interesting facts by which we often think to re-clothe the dead bones—or in this case perhaps one should say shells—of morphology. The types included are as follows: *Paramœcium, Grantia, Pennaria, Sertularia, Tima, Gonionemus, Aurelia, Metridium, Dendrocœlum, Dicrocœlium, Tænia, Ascaris, Lumbricus, Nereis, Hirudo, Daphnia, Homarus, Schistocerca, Agelena, Asterias, Ophiopholis, Pentacrinus, Arbacia, Thyone, Venus, Limax, Loligo* and *Molgula.* This list is comprehensive and probably represents as much work as can be accomplished in the time allotted to a course of this nature. Other forms are promised, if the sales warrant a subsequent edition. From the morphological standpoint, this list is excellent and the reviewer would only suggest that the addition of another Gastropod, preferably *Helix,* of notes on the fresh-water mussel and of something further upon the Entomostraca would be of value. The presence of the fluke *Dicrocœlium lanceatum* in the list is an innovation which will doubtless be welcome to American zoologists, since it is so highly recommended; though the reviewer has found a fluke from the frog's lung, which he identifies as of the genus *Hæmatolœchus,* extremely satisfactory when properly fixed and stained. The very complete account of the spider *Agelena nævia* is a valuable addition, as the arachnids have often received scant attention, and reflects the author's familiarity with this class of invertebrates. In a paragraph entitled "Material," which appears at the beginning of each chapter, there is given a brief statement of the specimens and preparations needed for the work outlined and of the author's methods of technique. This information is valuable and in a number of instances, such as the use of a leaf in the killing of *Dendrocœlum lacteum* mentioned on page 55 and the method of preparing *Tænia,* page 72, the reviewer notes methods with which his experience in invertebrate zoology has not made him familiar.

The distinctive feature of the volume is the elimination of explanations and interrogations from the *Instructions* and the inclusion of all such matter in the *Descriptive Part* which is a morphological monograph of the form under discussion. The "instructions" are reduced to such a degree that those for the simpler forms and the sections of those for more complex forms covering any one day's work might almost be written out in full on a blackboard of moderate size. There is no attempt to put the student through his paces or teach the method of induction through the medium of the laboratory instructions. Such brief directions demand rather more of the instructor, but the plan is a good one with students of the class for whom the book has been written, as the reviewer knows from having once or twice tried a similar scheme in his own classes. In looking through these instructions one gains an impression that there are some drawings suggested which are too difficult for any one without pronounced artistic ability, as, for example, the figure of the mouth parts of the lobster mentioned on page 137, and there is perhaps a tendency toward more isolated figures and fewer larger and more comprehensive ones. This statement, however, represents an impression which might not be justified after the actual use of the book in the laboratory. As a matter for special commendation, the author of this review notes the procedure outlined for the dissection of *Molgula,* which can be recommended since it is essentially like a method which has been developed in my own laboratory after some disappointment at the failure of students to master what seemed an easy matter.

The figures are few in number, but in the main good. Those of the Nematode on pages

80 and 82 and the longitudinal section of the lobster on page 129 are obscure and need to be redrawn with a view to clearness and perspective. The old Parker & Haswell figure of Anodonta which appears on page 209 has been through the mill of text-books in the past twenty years and looks it. By comparison with its appearance in the original edition of the work from which it was taken it presents a sorry spectacle and it is time such a plate went to the scrap-heap. In Figs. 28 and 31, the explanations are written at the ends of label lines and not below with reference letters or abbreviations on the figures. Without criticism of the present work, we may ask why this practise is not more common. The time required for reference is distinctly less and the eye work not so much of an effort in the examination of a figure so labeled. The great majority of the figures in this volume might have been labeled by writing the words in full at the ends of the label lines, and when we come to recognize the importance of every little saving in eye strain this is one of the reforms which will be effected.

It is stated in the preface that "the student is expected to read the descriptive part at home, the day before" and thus to prepare himself for the laboratory exercise. The reviewer objects to this on pedagogical grounds because in his experience one of the least profitable things a student can do is to read accounts of things he has not yet seen when it is possible for him to see them first and particularly when he is to see them next day. Although quite familiar with most of the forms included in this volume, the reader will find it something of an effort to picture to himself the morphology of the animal in question, and what must it be to the student who has never seen the inside of a starfish or a squid. Can he really do otherwise than create at some labor a mental picture which he will find incorrect the next day and which might have been simply and correctly formed if such a morphological account had followed rather than preceded his study of a given form. The experience of one of my old teachers, who once remarked that for twenty years he had tried to understand *Nautilus* from accounts in published papers and always thought of it as a form with structures most difficult to understand, comes to mind. At last by chance he obtained a specimen which he was able to dissect for himself, and then he wondered at its simplicity and thought how few difficulties the animal would present to one beginning with the actual specimen. In a work like the present volume, the individual instructor is left free to use the monographic parts in any relation to the laboratory work he may choose and the writer believes that, as a matter of economy and efficiency in learning, the student should use these accounts at the same time or subsequent to the laboratory study, for it is very difficult to understand such matters in advance where the figures are so few. The only difficulty in the way of such use of the present volume is the brevity of the instructions, which are, of course, written with reference to the monographic accounts; but there should be no difficulty in the student's using the two together as he works in the laboratory, since both are in one volume. We should not object to reading in the laboratory save that it can also be done elsewhere, and it would be a fortunate thing if we could make the laboratory more a place of quiet study both of animals and of books than one for an altogether mechanical process of dissection and drawing. My suggestion for the efficient use of such a book would be that the student read the monographic parts as he needs them in the laboratory and again with great thoroughness in reviewing his work and when his completed drawings may serve as illustrations; though for my own purposes I prefer a less complete separation of "instructions" and "explanations."

Other points which had been jotted down in reading for this review appear now of such a minor nature that to mention them might seem like petty criticism. The book is well done, clear, concise and to the point and shows a mastery of invertebrate morphology which may be envied. It is not a work which gives the impression of having been carelessly put together. Whatever criticisms one may have, it should be remembered that it is for the

use of older students who will have their own ways of working, and the very brevity of the laboratory instructions allows greater latitude for both student and teacher. The older courses in invertebrate zoology are being crowded in these days when zoology has developed so much of interest, but some of us have always insisted that it is preposterous for a man to go into zoological work without at least as much knowledge of invertebrate morphology as is set forth in this volume and a man should get this as an undergraduate. Students who have other scientific interests or whose interest in zoology has no direct relation to their subsequent work may well elect, after an introductory study, other courses in preference to this; but for the young zoologist such a knowledge of morphology is a foundation stone, and perhaps our author has produced a volume that will be more lasting because it makes no attempt to modernize the invertebrate course, but offers it on an exclusively morphological basis, leaving the other things to the newer courses in ecology and parasitology and field zoology which are already in our midst.

In behalf of the publishers it may be said that the typographical work is up to their usual standard and the surface and quality of the paper ideal for a work of this nature.

Winterton C. Curtis

CAPTAIN WHITE'S RECENT EXPLORATORY WORK IN AUSTRALIA

For several years past I have corresponded regularly with that most indefatigable explorer of certain unknown regions in Australia —Captain S. A. White, of Adelaide. Captain White, who is a member of many scientific societies and institutions, resides upon his elegant estate at Fulham, South Australia, and almost every year, in one capacity or another, he becomes connected with expeditions that explore the entirely unknown regions of the far northwest parts of the Australian continent. On these trips he is accompanied by his wife, who cheerfully shares her husband's trials and dangers, and she is more than entitled to her quota of the glory and credit of their common discoveries. No fewer than fourteen of these hazardous trips have been made—some of them lasting many months—the travelers pressing their way into the most remote and unexplored districts of this great island continent. Upon the return of the expedition, Captain White usually publishes their discoveries in some of the scientific journals, such as the *Transactions of the Royal Society of South Australia;* but in addition to these accounts he gets out popular ones in booklet form, and he has kindly presented me with several of these, covering some of the more important expeditions. The last one of these is now before me; and, as its recorded results, discoveries and contributions to science are so remarkable, I am sure that no apology is required for making a brief notice of them here.

This, the fourteenth excursion of the kind, was made during 1914, the start having been made about the middle of June. On this occasion Captain White officially represented the Royal Society of South Australia and the Royal Geographical Society of Australia as the associated naturalist, and he was fully equipped for the most varied duties pertaining to that part of the work. Mr. G. M. Mathews, F.R.S.E., the distinguished ornithologist of Australia, accompanied them, with other noted individuals, the party as a whole being a large one. Baggage and collecting material of all kinds was packed on camels, sixteen of these valuable animals forming a part of the expedition, which, for this particular year, was known as the "Geological Survey Expedition." It started at the terminus of the railroad on June 17, 1914, at a place called Oodnadatta, with all hands well and everything in fine shape. After reaching the Alberga River, it followed this stream more or less closely for a long distance, and then made direct for the Everard range of mountains, where considerable collecting and survey work was accomplished. Skirting the foothills, it returned to Moorilyanno N. Well, and took a side route to examine Indulkana Spur and neighboring territory. The route then led to the Musgrave ranges far beyond, the expedition being subjected to terrible hardships on

account of the heat, the drought that prevailed, lack of water, and similar causes.

Captain White's booklet of 200 pages is a day-to-day record of the entire history of this expedition, with a detailed account of its achievements for science. He took many valuable photographs of natives, animals, botanical specimens and localities, and not a few of these have been reproduced to illustrate the little volume, while a map of the route traversed is inserted opposite the preface. Many of the mammals, birds and other forms of life are described in great detail, and in the most lucid and interesting manner. A great part of this must necessarily be omitted from the brief notice I am now writing, and the space allowed me given over only to a reference to the more important discoveries and results achieved by the party. Among the first successes scored was the rediscovery of John Gould's long-lost bird, *Aphelocephala pectoralis,* formerly *Xerophila pectoralis,* a single specimen having been taken in 1871 and lost shortly thereafter. Several specimens were obtained by Captain White and his most efficient collector, Mr. J. P. Rogers. On one page he writes, about six or seven days after the start:

> A little after noon we reached one of Mr. Breaden's wells near Murdaruma, on the Woldridge Creek, where the camels were watered and we had some lunch. One of those tragedies which are so often enacted in the far-back country came under our notice. A bait had been laid for wild dogs, and a fine dingo had been successfully poisoned; but, unfortunately, a party of wedge-tailed eagles had attacked the carcass of the dog, the result being that some of these fine birds lay dead around, the great wings stretched out (they are the largest eagles in the world) over the ground in their last agonies, others were sitting round, unable to escape, due to the paralyzing effect of the poison (p. 16).

All the scientific members of the expedition became much excited as it approached the Musgrave range, for scarcely anything was known of the flora and fauna there, and footprints of the "wild men" had already been discovered by the camel drivers. Almost at once a new plant was collected, and it has since been named by Mr. Black *Foxanthes whitei.* The weather was cold, and the water-bags froze hard during the night. There is a fine description given of Glen Ferdinand, and of some of the remarkable birds found in the surrounding region. Among these may be mentioned the rare blue-vented parrot (*Neopsephoatus burkii*), the crested pigeons (*Ocyphaps lophotes*), the white-fronted honey-eaters (*Ramsayornis albifrons*), and the curious little buff-throated grass-wren (*Diaphorillas t. purnelli*), a most extraordinary species both in coloration and in habits.

Some of the species of ants met with are described in detail by Captain White, and the description of their nests and their ways makes a most interesting chapter, not to say a very remarkable one.

Some of the boulders and rocks and walls of the great caverns had strange pictographs upon them, drawn there by some unknown natives; there were other evidences of the latter's existence.

In due time the expedition returned to the Everard ranges; the main one was entered and the signs of the existence of natives became more abundant. Footprints were fresh, and every one felt that these strange people would soon be met with in their own little-known land. Soon they were heard giving signal calls, which a native with the expedition answered as best he could, for he was not of their tribe. Finally a dozen or so of them put in an appearance. Captain White says:

> They were all armed with two or three spears of the single-barb variety, which they called "ooruta," a yam stick, "wanar," and they also carried a long-shaped wooden bowl, "mera," which is used for carrying food, for scooping out the sandy soil when hunting for food, and for many other uses. They did not wear covering of any kind. A single or double strand of hair string encircled their waists, and their chests were covered with red ochre, with a circle of white down from the wedge-tailed eagle, extending from one armpit down to the lower part of the chest and up to the other armpit; the down is stuck to the skin by means of human blood. They were mostly young men, and their hair was bound into a chignon shape, which stood out, in some cases, over a

foot behind and was decorated with hawk's feathers (p. 76).

As these natives followed along with the expedition for a number of days, Captain White was afforded the opportunity to study not a few of their habits and customs; indeed, before this exploratory excursion drew to a close, he not only was the discoverer of an entirely new tribe, but he contributed a mass of ethnological and anthropological knowledge to what we formerly knew of the native tribes. This was not only new, but also of great importance, especially in view of the fact that these black men are now gradually being eliminated by the whites, and will soon become utterly extinct. Miscegenation with respect to the two races practically amounts to nil; moreover, the native women, as in the cases of other low races, are usually nonfertile in such crossing.

The women of this tribe never wear clothing of any kind, and Captain White's photographs of them exhibit those he succeeded in obtaining entirely nude. They have great affection for their children, and are much pleased when strangers pay them any attention. The peculiar ceremonies of this tribe are described by our intrepid explorer with very considerable detail, and among other things he remarks:

> The dry watercourse before mentioned still traversing our line of march, we were at times passing over its loose, sandy beds, with a row of redgums (which lined the watercourse) on either side. A native would give forth a sharp exclamation while looking up into one of the gumtrees. Then, in the twinkling of an eye, half a dozen natives would be up that tree, their lithe, muscular and naked forms moving from branch to branch with the ease of apes. They were in search of the large white grubs, or larvæ, of a well-known moth, which passes the first part of its existence boring in the gum wood. These grubs are much sought after by the natives, who call them "margoo." It is wonderful how they can tell at a glance if the grub is at home, and how well they can make a hole in the gum wood with a sharp-pointed stick hardened by fire! When the search was over, down they would come again to mother earth with a grunt, and on the march again. Not an item of anything missed these happy children of the desert. They would try to show me a bird, a reptile or an insect at a distance when the object was stationary; and after several minutes of vain attempts to show me where it was, the object would move off; if I showed my vexation, they would laugh softly and pass remarks among themselves. Tracks, which these wild men saw at a glance as they walked along, the sight expressed only by a nasal "hem, hem" and the outspreading of the fingers, or the pointing in a certain direction with the index one, were not revealed to me, when, on hands and knees, I was peering into the spot where the track, to my dusky companions, was easily seen; and when I rose with a shake of the head, they only quietly laughed and passed on, wondering, no doubt, at the slow-witted white man.

Captain White found but few mammals in the country traversed, and snakes, too, were rare. Upon the other hand, quite a number of new birds were taken, and the specimens brought back with the party. In fact, ninety-four species of birds were collected, five of which were new. Many undescribed insects were found in the stomachs of the small birds brought back, and the main collection of spiders and insects contained a great many more entirely new forms. New moths and ants were also taken, the latter being worked up by Professor W. M. Wheeler, of Harvard University. Professor Wheeler found nineteen species of ants new to science. Five new plants were found in the two hundred species collected, one of which was a heretofore undescribed species of tobacco.

Another expedition will soon be organized; doubtless many more novelties will be discovered, and more exhaustive studies made of the rapidly disappearing natives.

R. W. SHUFELDT

WASHINGTON, D. C.,
September 14, 1916

SPECIAL ARTICLES

THE OVULATION PERIOD IN RATS

THERE are many observations on the occurrence of ovulation in mammals; but very few investigations on the regular recurrence of that event, perhaps because of the fact that such investigation must involve the systematic study of sections of whole ovaries and oviducts of animals killed at frequent intervals over

a considerable period of time. This has been done by Leo Loeb for the guinea-pig. For the rat there are no published observations except those by Kirkham and Burr (1913), from which it is to be inferred that the ovarian cycle has a length of twenty-one days.

Although further studies on the rat are being carried on by the senior author, it seems worth while at this time to present in outline the chief conclusions arrived at, reserving for a later paper a more complete presentation and discussion of evidence.

The most obvious and certain evidence of the occurrence of ovulation is the presence of eggs in the oviduct. It is chiefly upon this kind of evidence that the conclusions are based. There is also a further source of information concerning the ovarian cycle in the corpora lutea, formed in most cases from the ripe follicles which have discharged their eggs. The corpora lutea grow and undergo such changes before degenerating that there may be as many as 40 in one ovary, of which only the youngest and oldest can sometimes be identified with certainty. However, the newest corpora up to an age of about 2½ days can be distinguished from older ones. Such young corpora are always present when eggs are in the oviduct, and their absence when no eggs exist in the tubes is additional proof that ovulation either has not occurred (especially if the ovary contains large follicles), or took place several days before.

All of the 80 females used were isolated from males before their last litters were born, and thereafter were kept alone or with other females. Also their young were at once removed, usually before being suckled.

The ovaries and oviducts were sectioned, the position of the eggs (when present) in the oviduct was determined, and the condition of the corpora lutea noted. The animals were killed at intervals during 101 days after parturition, 67 of the 80 rats being taken during the first four 10-day periods as follows:

1	to	9	days,	18	rats
10	"	19	"	15	"
20	"	29	"	17	"
30	"	39	"	12	"
40	"	42	"	5	"

making an almost complete series at one-day intervals. They are grouped at still closer intervals about the tenth, twentieth, thirtieth and fortieth days. The rest of the animals were killed only at about ten-day intervals from 50 to 101 days.

Unfertilized eggs pass through the oviduct in about three days, usually having degenerated by the end of that time, as determined by a study of 15 animals killed during the first four days post partum. Accordingly the distance traveled by the eggs in the oviduct is of importance and was taken into account in estimating the time of ovulation.

Of the 80 animals examined 49 revealed eggs in the oviduct. To these may be added 14 more in which it is permissible to estimate the time of ovulation. Summarized they are as follows:

Ovulating after Parturition

Rats	Days	Average
15	.... ¾– 1	
11	.... 9½– 13	11
1	...........15½	
13	...........19 – 23½	20
1	...........24½	
5	...........27½– 34½	30½
5	...........38 – 41½	39½
2	...........49½– 50	50
2	...........57½– 58½	58
2	...........67½– 70½	69
2	...........78 – 82	80
2	...........87 – 89½	89
2	...........97½–101	99

Of the other 17 rats none had eggs in the oviduct, and the ovaries presented no evidence of recent ovulations. They were killed between the periods enumerated above.

The foregoing indicates that female rats when kept isolated from males ovulate on the average every 10 days.

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OVULATION IN MICE

It has been known since the time of Tafani (1889) that mice normally ovulate soon after giving birth to litters. According to Sobotta (1895) a second ovulation takes place in

nursing mothers on an average 21 days after parturition, a discovery he made use of in his study of maturation. There are no other printed records of spontaneous ovulations in addition to that coming immediately after parturition.

The following is a summary of the results, with respect to the occurrence of ovulation, of an investigation, still under way, of the ovarian cycle in mice. The study is being carried on in the same way as for rats outlined in the preceding article.

Sixty-two female mice of various coat colors were bred, allowed to have their litters when isolated from males, kept alone or with other females, and killed at intervals during a period of 91 days. Most (52) were killed during the first 56 days at intervals of about 2 days, except between 18 and 21 days, 34 and 38, and 50 and 56 days when the interval was a day or less. The rest of the animals were taken between 70 and 74½, and 87½ and 91 days.

The sections of the ovaries and oviducts were examined for eggs in the oviduct and for the youngest corpora lutea. In determining the time of ovulation the position of the eggs in the oviduct was considered; and the presence or absence of the youngest corpora lutea was used as a check.

The examination of these mice indicated that the second ovulation occurred at from 15 to 19 days following parturition, the third at about 35, the fifth at 69 to 72, and the sixth at 87 to 90. No ovulation was found at the expected fourth, perhaps because too few animals were killed at that time. But it is significant that of those animals killed at 70 to 74, and 87 to 91 days which fall within the expected later ovulation periods, 3 and 2 animals were found to have ovulated at the sixth and seventh periods respectively; also that none of the mice killed between the ovulation periods was found to have ovulated.

It thus appears that the normal ovulation period in mice recurs at about 17½ to 18 days.

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AGAR AGAR FOR BACTERIOLOGICAL USE

Agar agar is used by so many, as a basis of nutrient media, that any suggestion as to how to select the most suitable grade is worthy of consideration.

Fellers[1] has recently published some bacteriological studies on agar agar. The same author[2] has also prepared a paper on the composition of agar agar and given methods for purifying commercial agar. No matter how easy the method proposed for the purification of a substance is, we have to select that which we intend to purify. One of the best ways of determining the stability of an organic substance is to find out how much it will be hydrolyzed under the conditions it is to be used. Hydrolysis is, generally, increased with temperature, and thus increased acidity at high temperatures is often due to greater hydrolysis at the high temperatures. If substances show an increased acidity at high temperatures, but when cooled back to normal temperatures return to the acidity they had before the heating, the high temperatures have not materially changed their composition. Some samples of agar agar have been known to develop a large increased permanent acidity due to autoclaving. It is evident that such samples should not be used for accurate work. The increased acidity due to autoclaving and due to titration made in hot solutions can be made use of in selecting agar agar for laboratory use.

The following described test has been found to designate the superiority of some samples of agar agar over others. Samples chosen by means of this test are always those which go completely in solution when heated with carbon dioxide free distilled water. Further media made with them have a lower acidity than media made with agars not so good by the test.

THE TEST

The test depends on the increase in acidity of water solutions of the agar due to autoclaving and to titrations made near 100° C.

[1] Fellers, *Soil Science*, Vol. II., No. 3, p. 255.

[2] Fellers, *Jour. Ind. and Eng. Chem.* (Article to appear soon.)

Several samples of agar each claimed to be the best that some commercial house has in stock are secured. Powdered and shredded agar are used alike. The shreds are cut up into half-inch lengths, so that aliquots may be more representative. (An ordinary print trimmer makes a very satisfactory agar cutter.) As many 500 c.c. Erlenmeyer flasks (Jena, pyrex or non-sol glass) as there are samples to be tested are cleaned, dried and weighed to within 0.1 gm. 4.5 gm. of agar agar are put in each flask and enough carbon dioxide free distilled water added to make the contents of the flask up to 300 gm. The flasks are shaken and put in a bath containing boiling water. They are shaken at intervals to aid solution of the agar. When the agar has dissolved the flasks are removed and contents brought up to original weight with hot carbon dioxide free distilled water.

25 gm. aliquots of the agar solutions thus prepared are weighed out in triplicate into 350 c.c. Erlenmeyer flasks (Jena, pyrex or non-sol glass) which have just been rinsed with hot carbon dioxide free distilled water. The triplicates for each sample are designated for convenience *A, B, C*—thus those from sample No. 1 would be 1*A*, 1*B* and 1*C*.

To each *A* flask is added approximately 250 c.c. of hot carbon dioxide free distilled water. The flasks are shaken until the contents appear homogeneous. They are stoppered and set to one side until they attain room temperature.

The *B* and *C* flasks are tightly stoppered by cotton plugs and autoclaved for 15 minutes under 15 pounds pressure. After autoclaving about 250 c.c. hot carbon dioxide free distilled water is added to the *B* and *C* flasks. The *B* flasks are restoppered and left to cool to room temperature. The *C* flasks are set on a steam bath. When the contents of the *C* flasks are up to 95° C. or above, they are removed individually and titrated at once with *N*/10 or *N*/20 carbon dioxide free alkali. One drop of a 1 per cent. phenolpthalein solution is used as the indicator. The titration is finished when the faintest discernible, yet permanent, pink color appears. The *A* and *B* flasks are titrated in the same manner after they have cooled to room temperature.

CURRENT YEAR'S TEST OF AGAR AGARS

Seven samples of agar agar were secured in answer to letters to five concerns. Five samples were shredded agar, one a powdered agar and one, "Bacto Agar." Sample No. 1 in the table is the powdered agar and No. 4 is "Bacto Agar."

All samples were uniform, clean and bright, except No. 5, which was darker, dirty and ununiform.

TABLE I

Acidity of Agar Agar Solutions and Nitrogen Content of Agars Used

No.	Titrated R. T.,[3] NA.	Titrated R. T., A.	Increase due to A.	Titrated H., A.	Nitrogen in Agar
1	.060% (a)	.040%	−.020%	.100%	.27%
2	.040	.080	+.040	.120	−(1)
3	.040	.060	+.020	.140	.31
4	.040	.060	+.020	.088	.31
5	.052	.080	+.028	.142	.16
6	.036	.032	−.004	.076	.27
7	.044	.052	+.008	.100	.27

THE TABLE SHOWS

1. That the maximum variation in acidity between samples of agar agar when titrated at room temperatures is only .024 per cent. before autoclaving, but is doubled by autoclaving.

2. Titrating the autoclaved aliquots when hot accentuates the differences between samples, the maximum variation being greater than the greatest acidity of the unautoclaved aliquots.

3. Sample No. 6 has the lowest acidity in all cases.

Sample No. 6 is the most stable because autoclaving and heating change its reaction least.

H. A. NOYES

PURDUE AGRICULTURAL EXPERIMENT STATION, LAFAYETTE, INDIANA

[3] R. T. = Room temperature.
A. = Autoclaved.
NA. = Not autoclaved.
H. = 95° C. or above.
(1) = No sample left for determination.
(a) 1.0% = requirement of 1. c.c. normal acid per 100 c.c.

SCIENCE

Friday, December 8, 1916

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

MEDICINE AS A CAREER[1]

Students of Medicine: You have chosen your life work. You have elected to devote your time and energy to the science and art of medicine. It is hoped that you fully realize the importance of this decision and that you have not come here without adequate deliberation and comprehension of the heavy tasks you have assumed in taking this step. In view of the possibility that some of you have made a mistake, I have decided to spend this hour in presenting to you a few of the duties and obligations which you are assuming and if there be among you those who feel that the burdens to be borne are too heavy and the personal gain too light, let such not hesitate to stop and turn back on the threshold. Medicine needs recruits, but it desires and will accept only those who, after severe tests, it deems worthy. I am aware of the fact that the words of the experienced fall lightly upon the ears of the inexperienced, but one who has served in the ranks for nearly forty years offers you advice. I wish to say that the fatality among medical students is great. In the past ten years, less than sixty per cent. of those who have entered this school have succeeded in winning its diploma, and of those who have gained this distinction not all have fulfilled the confidence imposed in them by the faculty. It is not my expectation that you will do better than preceding classes.

Medicine embraces all facts which may be utilized in the prevention or alleviation of diseases. Its chief contributory sci-

[1] Address at the opening of the University of Michigan Medical School, October 3, 1916.

ences are physics, chemistry and biology. It is for this reason that a knowledge of the fundamental principles and facts of these basic sciences is required for admission to the better medical schools. Some of you will fail because your training in these sciences has been inadequate. Teachers in the medical school can not take the time nor can they hold back better trained students to instruct those who are deficient. By the end of the first year most of these unfortunates are asked to withdraw.

With the best possible preparation the medical student finds his daily task quite as much as the strong can carry and altogether too heavy for the weakling. There has been some discussion among medical educators concerning the curriculum, some contending that it is too heavy for the average student. This depends upon what is meant by the "average student." If the standard set in college work is applied, I am of the opinion that medicine does not want such "average students." I am convinced that a strong student, of a high average, can carry the medical work as now imposed and that the imposition of a heavy task succeeds in weeding out the unfit and is therefore desirable. We do not develop muscles by lifting feather weights, nor do we strengthen brain activity without earnest effort. The aim of medical education is to develop strong men, and in order to do so difficult tasks must be imposed in the training.

A strong intellect is not enough to insure success to the medical student. Intellect must be backed by industry, otherwise it is of but little value. For lack of industry many medical students fall by the wayside. After forty years as a teacher in this school, I am of the opinion that lack of proper application to the work is the most potent cause of failure among the students. In his collegiate course the work has been light, easily done. He has had a good record, but has failed to establish habits of study. Some allurement causes him to neglect his tasks for a day and then for a week. Soon, he finds himself quite in the rear. His bluff at recitation does not go. His teachers question his intellectual strength and honesty. He becomes a derelict and must be removed for his own and others' good.

A third essential to success in medicine is integrity. When endowed with a high degree of intelligence, supported by the greatest industry but without integrity, the medical man is likely to prove a disgrace to his profession and a menace to the community in which he lives. That integrity has been regarded as an essential qualification of the practitioner of medicine from the earliest times is shown by the exaction of the Hippocratic oath supposed to have been formulated by the father of the profession. The medical man must be honest with himself, his patients and the public. For personal gain he must not pretend to greater knowledge or skill than he possesses. Professional ethics insist that in the announcement of his purpose to serve the community he must restrict himself to the simplest statement. The public has long ridiculed the restrictions which the medical profession has attempted, with more or less success, to impose upon its own members, but that the public is now reaching a point where it appreciates the righteousness of medical ethics is shown by recent legislation forbidding false and exaggerated advertisements. The first thing for the honest man in becoming a physician to do is to secure the best possible preparation. To enter upon the practise of medicine or to continue in it without adequate preparation is a crime—a moral, if not a statutory one. The public has come to this view and there is no other profession, admission to which is so strictly guarded as that of medicine. State laws set the stand-

ards of admission to medical schools and state licensing boards test medical graduates. The best intentions do not supply the deficiencies due to lack of knowledge and skill. It certainly can be said that in the practise of medicine knowledge is a virtue and ignorance a crime. Recognizing the fact that no man, however great his intelligence and untiring his industry, can be skilled in all branches of the healing art, individuals select specialties in which they strive to make themselves experts and these so group themselves that each patient may have the advice of an expert. The wisdom of this procedure and its advantages to both practitioner and patient must be evident to all. Each individual in such a group must know his specialty and must keep in touch with its progress. Medicine is a progressive science. Each year adds to its effectiveness. Discoveries in physics, chemistry and biology find practical application in the prevention or cure of disease. It follows that the efficient medical man must continue to be a student so long as he remains an active member of the profession. In medicine there are no "papal bulls" no "ipse dixits" and even "precedent" is shown but scant respect. It is best compared to a living plant constantly drawing sustenance from soil and air, dropping its withered leaves and branches, ever putting forth buds and blossoms and bearing each season better fruit. One who is not capable of sustained effort should seek some other calling in life. Occasionally I meet with men who are still living professionally in their undergraduate days, reading the same old books, and writing the same old prescriptions, both blind and deaf to the changed environment. Fortunately the more intelligent of the public easily recognize these fossils and appraise them at their true worth. They are interesting as relics of the past, but worthless in the present.

From the time of Hippocrates to the present, wise men in the profession have always advocated amity among its members and I must say after many years of personal experience that there is no other high professional ideal so difficult in realization, but I am proud to add that there never has been a time when the promise of the realization of this ideal has been so great as at present. In this matter medical men have learned much from the commercial world in which the value of cooperation has been so abundantly demonstrated. The efficiency of the individual has been increased and the value of the product has been improved. Much regret has been expressed concerning what is called the passing or the elimination of the old-time family physician or general practitioner. In the slow development of scientific medicine he served his fellow men, often with the greatest devotion and self-sacrifice. The history of epidemics shows him to have been often worthy of the highest honor. He has faithfully served his fellow men in times of dire distress. Occasionally he has made contributions of the greatest value to science. In the record of the slow progress of man from the marshes of ignorance and superstition to the uplands of knowledge and science he bears a conspicuous and honorable place, but in the practise of modern medicine his part is a subordinate one.

In any community in which several physicians are singly doing a general practise, cooperation, with the development into skilled specialists, results in individual efficiency among the medical men and better service to their clientele. With a properly equipped hospital at their service, a group of village physicians may give their patients the same scientific and effective treatment that they can secure in larger medical centers. I have no sympathy with the contention that our rural population de-

mands cheaply educated physicians. With trolley cars and automobiles there are but few in need of medical aid who are so located that a good physician may not soon reach them, or what is better, that they can not soon be transported to a hospital. A friend who has long practised in a small Montana city recently told me that twenty and more years ago his ride sometimes carried him one hundred and twenty-five miles from home. One such visit to a case of pneumonia is unsatisfactory to the doctor and of but little benefit to the sick man. Now, the automobile brings the patient to a well-equipped hospital where several physicians may daily consult concerning the case and trained nurses be constantly in attendance.

When I was in medical practise, like the milk man, I made my daily rounds, seeing cases of scarlet fever, diphtheria, sometimes smallpox, pneumonia, various nervous diseases, attending cases of labor and in short I was a general practitioner. Like others of the kind, I did the best I could for all and I am able to say with some pride that in no case did I carry infection from house to house. However, in order to avoid this I often had to change my clothing and disinfect my person many times in one day. This kind of practise is still largely in vogue, but it is gradually being displaced by hospital treatment in which specialists direct and trained nurses administer. The greatest need of practical medicine to-day is more and better equipped hospitals. With these the specialist and the skilled nurse will multiply and improve. Such hospitals should be supplied with thoroughly equipped and competently manned diagnostic laboratories which should serve not only curative but preventive medicine. Water and milk supplies should be examined daily and visiting nurses under the direction of a competent health officer should constantly patrol the community. Adjunct dispensaries which should serve as schools of instruction in baby feeding and care, child welfare, home sanitation and in everything pertaining to healthy living should supplement the community hospitals. When in addition to these agencies the people generally can be educated to see the benefits that would follow the periodic thorough examination of all in order to detect the first departure from the normal, then medicine will be able to render its highest service to mankind.

It must be evident that if these hopes are to materialize the practise of medicine must become more and more a state function. That the tendency is in this direction and that this should be encouraged for the public good are not matters of doubt in my mind. Only a few years ago some of the most eminent men in the profession combated earnestly state support of medical education. They claimed that the state had no right to establish and maintain medical schools and that such aid was not fair in competition with the proprietary schools, which at that time educated more than ninety per cent. of the annual recruits to the profession. Now, no one questions either the right or the duty of the state to establish and support medical schools, while the proprietary schools, having proved wholly inadequate and inefficient, have practically ceased to exist. Even the man in the street sees the advantages that have resulted from these changes. To state that a medical school is a proprietary one, in the sense generally understood by that term, immediately condemns it with intelligent men. Courts from the lowest to the highest in the land have uniformly held that the state has the right to maintain its own medical school, also to pass upon the merits of other schools both within and without its borders, to set up standards

of medical education, to define the requirements of admission to medical schools, to submit those who wish to practise within its borders to certain intellectual and moral tests in order to pass upon their professional fitness and to revoke the licenses of the unworthy. The federal government has its public health service which passes upon immigrants, controls national quarantine, maintains a research laboratory, supervises the manufacture and sale of vaccines and antitoxins, and stands ready to aid any state in combating epidemics. Each state has its board of health, the powers, functions and efficiency of which vary widely. Our great municipalities have their boards of health and commissioners of health which for the most part are efficient, but in some instances are parts of a political machine. Our smaller cities and rural communities have their boards and health officers, which with some notable exceptions, fortunately in increasing numbers, are cheap, ignorant and inefficient.

By means of these organizations, imperfect as many of them are, the death rate in the registered area of the United States has been reduced in the past thirty years from twenty to fourteen per thousand, the average life has been increased more than ten years, and the mortality from tuberculosis and other infectious diseases has been reduced about fifty per cent. On account of the greater efficiency of the health service in our larger cities, the reduction in the death rate has been more marked in these than in smaller cities and rural communities. The greatest reduction in mortality has been secured in our cities of one hundred thousand or more. Our metropolis, New York, has a municipal health service which is second to none in the world. It supports a research laboratory in which the highest grade of scientific investigation is done, diagnostic laboratories in which diphtheria cultures, suspected sputum, blood examination and other tests essential to scientific medicine are made and laboratories in which water and food supplies are carefully guarded. It has a corps of expert diagnosticians ready to aid the practitioner in all suspected cases, free of charge to either the medical man or the patient. It provides medical-school inspectors who detect infection in its earliest stages, excellent hospitals in which the sick have the best care and treatment and nurses who patrol the tenements and other homes of the poor and give instruction in sanitation. It examines cooks and waiters to see that none of these may distribute typhoid fever, tuberculosis, syphilis or other infections. It inspects meat markets, bakeries, milk stations and other places of food supply and has the authority to close these when unsanitary conditions are found.

The last legislature of Michigan made an appropriation of one hundred thousand dollars and directed the state board of health to expend it in attempts to restrict tuberculosis. Several thousand citizens have already been examined free of charge in order that this disease may be detected in its early stages when it is amenable to hygienic treatment. These people are not only examined but those found infected are instructed how to live in order to avert the progress of the disease.

I have chosen to bring these matters before you in order to impress upon you the relation which the profession, which you have selected, bears to the public. Even the physician who devotes himself wholly to what is known as private practise does not escape his duties to the public. He is morally bound not only to do his full duty to the individual who employs him, but to protect the community. You have chosen to come to a school supported by the state.

Michigan practically gives you your education. Why does it do this and what does it demand of you in return for this great gift? It expects that you possess intelligence, for without this the gift is valueless; that you manifest industry both during and after your student life, for without this you bury your talent; that in all your actions, both professional and nonprofessional, you show the most sincere integrity, for without this you become a menace to your benefactor. The state has selected this faculty to ascertain to what extent each of you possesses these essential qualifications and I can assure you that those found wanting will not find their way into the profession through these doors. To those who prove worthy, every reasonable encouragement and proper assistance will be given.

I am sometimes asked what financial reward can the medical man reasonably expect? This is a proper question and I am ready to give it my answer. In the first place, a medical education, even with the relatively small tuition one pays in a state university, is the most expensive professional education, both in time and money, both to the state and to the student.

The laboratory expenses of the medical student are higher than those in any other school. Where other students buy books, he buys not only more expensive books, but he must also purchase a microscope, blood counter, and other expensive instruments. After graduation most medical students spend from one to three years in hospital work and at least one of these promises soon to become obligatory on all. When he begins practise the medical man must have a respectable office and a well-equipped laboratory. He must continue to buy expensive books, for the average medical book is out of date almost as soon as it leaves the press, so rapid has been the advance in scientific medicine in the past thirty years. He can not do without the best professional journals, and, being a member of a learned profession, he is ashamed to be ignorant of the best general literature. In his consulting room, his visits to the homes of his patient and in his association with his fellows he must be neatly, though he need not be expensively, dressed. He must supply himself with means for quick and comfortable travel. Without going into further particulars I may say that by the time he is ready to begin his professional work the most economical medical man has already made an investment of from ten to twenty thousand dollars, counting his actual expenses, allowing a fair amount for his time and calculating the interest on these amounts, and when he begins he must have the wherewithal to make his work successful. No medical man can neglect the financial side of his life's work. Without an adequate income he can not reach a high degree of efficiency in his work. However, the medical man who is imbued with the right spirit will use his financial gains largely in increasing his professional efficiency. After setting aside enough for the fair support of himself and those dependent upon him, he will devote the surplus —and there must be a surplus if he is to be successful—to better equipment, both physically and mentally. It has been my observation that the more intelligent laity respects the physician who endeavors to keep himself well posted and well equipped in his professional work. Medical men who attend their local, state and national societies are, as a rule, successful financially, while those who think that they can not leave their work even for self-improvement have a hard time in making ends meet. One who wishes to accumulate a fortune, or to become wealthy as that term is now understood, should choose some other call-

ing. I know of no one who has placed himself in this class by the reputable practise of medicine. Some medical men have made riches by fortunate investments, but this is an exception. Some marry wealth, but this is usually fatal to professional efficiency. I know of but one man who has demonstrated his ability by winning the highest distinctions in the profession notwithstanding the fact that he married a wealthy woman. While on this point, I may say that practise coming from the ultra rich is not to be coveted. They are exacting in their demands for service. They object to ordinary bills and cry out that they are being sandbagged. As I write this, I have before me such a letter from a millionaire. He admits that he selected the medical man on account of his recognized skill, that he knew what the charges would be before the services were closed and that he did not object at that time, because he was afraid that the medical man would desert him, but when payment was demanded, he claimed that he was being sandbagged because he was known to be rich. The ultra rich are familiar with the use of the sandbag in extorting money from others and they see its phantom in even the most moderate bills presented them.

The medical practitioner endowed with intelligence, fortified with industry and with his every action controlled by strict integrity is sure to make a decent living, care for himself and family in comfort and he need not sleep in a pauper's grave. He is not compelled to sacrifice his self-respect to expediency. His calling is quite as independent as any other. He can choose his own friends, church and political affiliation. The man who is sick with pneumonia or has an inflamed appendix does not consult the society columns, the church directory nor the polling lists when he selects his medical attendant. He prefers the man who is likely to render him the best service, and the intelligent public in the long run and on the whole judges wisely. There never has been a time when individual worth among medical practitioners was more correctly evaluated and, I may add, more highly estimated, than the present. Medicine has cast off the veil of mystery which once covered her face and walks among men uncovered and unashamed. The days of "divine healers," Indian medicine fakirs, and of Mrs. Winslow and Lydia Pinkham, are passing away. Some may say that these statements are contradicted by the wide prevalence of christian science, osteopathy and other cults. These are only the vagaries which have taken form in the delirium-racked brain of a fast-dying superstition. Did our government select any of these agencies in its successful combat with yellow fever in Cuba or on the Canal Zone? Has it relied upon them to keep Asiatic cholera or the plague out of this country? Did it send christian scientists or osteopaths to stay the epidemic threatened by the Dayton floods? Are these cults now busy healing the wounds and adjusting the dislocated bones so abundant on European battlefields? Our Lady of Lourdes and Ste. Anne Beauprie are apparently not on duty at a time when shell-torn and flame-tortured humanity is in greatest need of their much extolled, miraculous powers of healing. The genuine worth of scientific medicine has never been so thoroughly tested as in the present war. Amid unprecedented difficulties, in the camps where millions are congregated, in the quick transportation of corps after corps, in the trenches and even among the prisoners of war, always cared for grudgingly and reluctantly, everywhere, preventive medicine has successfully met her old foes, typhoid fever, dysentery, cholera, tetanus and other epidemics, which in

former wars have usually been the most destructive factors in the midst of contending armies, and have often decided battles and determined the fate of nations. Decisive victories have not yet followed the flags of the central or the allied armies, but in all the red cross signalizes the most triumphant achievement of man. International laws have been torn into shreds and become mere scraps of paper, moral and religious precepts and codes have been supplanted by brutalities never practised by primitive man and the foundations of civilization have seemed to be on the point of disruption and final collapse, but the spirit and ideals of scientific medicine remain unsullied and a new world in which these shall dominate will be created.

Medicine offers a number and variety of special activities to those who choose it as a career. First, there is the grand division into preventive and curative. The former is a product of the nineteenth century, the latter as old as the records of man. The oldest and still a widely dominant theory, as to the cause of disease is that it is an infliction laid upon man by some supernatural being. Primitive man, which term once embraced all, and in this particular, still includes many, probably a majority, even among the most highly cultured nations, believed in the existence of powerful spirits, who measured out good and ill to individuals as their own will might indicate. The religion of such believers consisted and still consists in attempts to propitiate these powerful, or one omnipotent, spirit. They built and still build altars of sacrifice and temples of devotion in which they proclaim their own weakness and implore divine protection and guidance. They still beseech a supreme ruler to shower blessings upon themselves and curses upon their enemies. In the hands of the Jehovah of the Jews disease was a scourge for the punishment of those who merited his displeasure. In the adoption and modification of the Hebrew religion by the Christian world, the idea of a God of wrath was adopted, and still prevails. Even to-day in battle-scarred Europe, the same God is invoked and his aid asked in each contending army. With this inborn superstition transmitted through countless generations, scientific medicine has had to contend. The combat has extended through centuries, as is shown by the earliest records of human achievement. The first signal victory was won when Jenner robbed smallpox of its horrors by the discovery of vaccination and success was assured by the labors of Louis Pasteur who marked the way by which each infection may be identified, controlled and abated.

An enlightened public is beginning to recognize that many diseases, especially the infections, are preventable and the medical profession is being called upon to plan and direct this work. Many of the smaller cities and some rural communities are providing for full-time health commissioners and the demand is greater than the supply. This and other universities are conducting courses specially suitable for public health officials. I am sure that some of you will select this field for the development of your life work. In it there is abundant opportunity to do credit to yourself while you serve the highest interests of your fellow man. The labors of Reed and his colleagues demonstrated the agencies by which yellow fever is spread, and Gorgas and his helpers freed Cuba from this disease and won a greater triumph in the Canal Zone. Laveran and Ross did even a greater service in showing how the world may free itself from malaria, which in all times has held some of the fairest and most fruitful lands under its curse. Preventive medicine is now capable of opening up the tropics as

suitable habitations for civilized man, of removing the stigma of being the "home and nursery of disease" from the fertile valleys of the Nile and of returning to cultivation the banks of the Euphrates and the Tigris on which the cradle of civilization was rocked. I can not believe that coming generations will be so insane as not to use this most potent agent in reclaiming the marsh, the wilderness and the barrens, and converting them into fields, rich in agricultural products and abundant in happy homes. Man's destiny is in his own hands and he may make of this earth a heaven of peace, plenty and prosperity, or he may mar it into a hell of strife, rapine and murder. In knowledge he has advanced to a position in which he becomes a co-worker with the Creator and he must bear the responsibilities which such power imposes. In the struggle between good and evil, knowledge and ignorance, science and superstition, medicine has, and must continue, to lead the way, and you as its standard bearers must serve your day and generation with intelligence, industry and integrity. I do not mean that you are to do your work, always conscious of the burden of duty. With all its imperfections this life is worth living and its highest joys lie in its contests. The man who does not get real pleasure out of his work remains a poor workman and his products do not find ready sale in the market. Even the bitterest disappointment, when you have done your best, often becomes a beacon light warning you of the rocks and leading you into a safe harbor.

It must not be inferred from the great stress that I have placed upon preventive medicine that the curative art is not equally worthy. Moreover, cure is not going to be replaced wholly by prevention. Disease and accident will continue so long as man reproduces his kind. The history of this, the older, branch of medicine is that of man's efforts to relieve the distress and to minister to the needs of his fellow man. Born in ignorance, nourished on superstition, clothed with mysterious rites and ceremonies, medicine has had a hard task to free itself from hereditary and environmental influences. Attempts to break away from these adverse and retarding conditions has marked the highest efforts of the race. During nearly every century since recorded history began, there have been some superior men, intelligent and far-seeing above the masses, who have contributed something to science. Such were Hippocrates, Galen, Pare, Servetus, Harvey and others whom we now delight to honor as contributors to knowledge and benefactors to the race. The discoveries, by empirical methods, of the specific effects of Peruvian bark in malaria and of mercury in syphilis did much to improve the condition of life and to enlarge the field of human endeavor. Since the scientific era began, the marvelous virtue of antitoxin in diphtheria; its great value in tetanus; the relief of cretinism by thyroid feeding; the action of thymol in hookworm disease; the benefit of salvarsan in the treatment of syphilis; the Pasteur treatment of hydrophobia; the prevention and cure of beri-beri by nutritional regulation—mark some of the most evident achievements in curative medicine. For diagnostic and prognostic purposes the medicine man of primitive peoples consulted oracles, watched the peristaltic movements of the intestines of animals offered in sacrifice, or read the fate of his patient in the positions of the stars. The physician of to-day employs the discoveries in physics, chemistry and biology for these purposes. The physician of fifty years ago was compelled to rely largely upon the study and interpretation of symptoms in which the best became highly proficient,

to-day he supplements these studies with the microscope, Roentgen ray, test tube, and other instruments of scientific precision. Then, his conclusions were drawn largely from guesses, now they are founded upon exact and positive knowledge. A large part of your undergraduate education will consist in familiarizing yourselves with the use and application of instruments of precision for diagnostic purposes. Each year brings forth advances in the fundamental sciences and medicine is ever ready to utilize such discoveries as may be of service in the prevention or cure of disease. It has been demonstrated that the physiological action and therapeutical effects of a chemical compound can be modified by changes in its molecular structure. The genius of Ehrlich produced salvarsan and its later substitutes in accordance with this principle, and the possibility of finding curative agents in other diseases by similar investigations is now occupying the time and energy of many laboratory students. While the achievements of preventive medicine have greatly reduced the numbers of those infected, medicine is not neglecting its curative agents and we can confidently expect great results in this direction.

The advance of modern surgery has been marvelous. No greater gifts has science brought to suffering man than surgical anesthesia, the discovery of which American medicine can justly boast, and aseptic surgery, made possible by the fundamental work of Pasteur and given practical application through the genius of Lister. These discoveries enable the surgeon to penetrate every part of the body and remove diseased tissue, repair injuries, extract foreign bodies and restore the individual to health and efficiency while he sleeps wholly unconscious of the operation. Plastic surgery has become a fine art and the successful transplantation of tissue is being practised in the base hospitals of Europe, where the brutalities of man are being ameliorated by skilful operation. The possibility of not only preserving but of growing animal tissue *in vitro* has been demonstrated and has developed a reasonable hope that the surgeon of the future may do still greater miracles.

The development of medicine must be preceded by scientific discovery, because medicine consists in the application of these discoveries. It follows that the highest duty of the medical man is to make contributions to scientific advances. In the past medical men have made an honorable record in this direction and there is no branch of science to which they have not brought valuable contributions. Even at the present, the open field of knowledge is of small dimensions, while on every side extends the boundless wilderness of ignorance. It has been a great privilege and a joy to have lived at a time when my chosen profession has been so rapidly moving forward and to have met face to face so many of its leaders. It has been my fortunate lot to work in the laboratory of that great German, Koch, to have listened to the words of that great Englishman, Lister, to have enjoyed the friendship of that great Russian, Metchnikoff and to have looked into the kindly face of the greatest man of the generation, if greatness be measured by good done one's race, that Frenchman, Pasteur. May some spark of the genius which led these men to great accomplishments descend upon and abide in you.

V. C. Vaughan

KEITH LUCAS

In the death of Keith Lucas on October 5, 1916, physiology suffered the loss of a really great investigator. At thirty-seven years of age he and his junior co-workers had already, as I see it, thrown more light on the fundamental functional properties of the excitable

tissues, nerve and muscle, than has been thrown by the combined efforts of all other investigators; and the possibilities of future achievement, had he lived, are altogether incalculable.

The great majority of his published writings have appeared in the *Journal of Physiology* and most of them reveal a common trend of thought. Although to appreciate the full meaning of this work and the brilliance of the experimentation one must read his papers, still it is possible to get some idea of his contribution from the Croonian Lecture in which in 1912 he summarized the results of his researches up to that date. In that lecture entitled "The Process of Excitation in Nerve and Muscle"[1] a comprehensive survey of crucial experiments brings out the broader meaning of his investigations, and shows the essential unity of the apparently diverse aspects of the subject with which he dealt.

We owe to him the first clear picture of the sequence of events involved in the phenomena hitherto loosely grouped under the term "excitation." He showed the great importance of the "local excitatory process" which is the immediate consequence of the external stimulus and which must be clearly distinguished from the "propagated disturbance" to which, if sufficiently intense, it gives rise. By a careful quantitative study of the "summation of inadequate stimuli" and of the time factor in the exciting electric current he laid the foundation for the completion of Nernst's hypothesis of excitation by Hill and for his own quantitative verification of the hypothesis in its modified form. With his characteristic modesty and sense of the limitations of our knowledge he claims for this verification only a "guide to the strengthening of our experimental data"; but to one less conversant than he was with the difficulties in the way of drawing final conclusions, it would seem that he had presented an excellent case for the conclusion that the local excitatory process is a concentration of ions at some point within the tissue.

In his more recent researches his attention has been given less to the nature of the local excitatory process and more to the properties of the "propagated disturbance" which results only when the former process reaches adequate intensity, and which is manifested by the electrical response and the refractory phase. Among these later papers is one which seems to me his most characteristic and brilliant work, the elucidation of the "apparent inhibition" of Wedensky.[2] The way in which this baffling phenomenon is dissected and explained step by step by means of exquisite and crucial experiments makes it the most perfect piece of scientific work I know of. Every experiment is so designed as to be crucial, to give unequivocally the answer to the question at hand; and the clarity with which difficult and complex ideas are expressed reveals an extraordinary gift of exposition.

In experimentation it was his most salient trait to devote his energies wholly to what really counted in yielding the result. He made most of his apparatus with his own hands, and he never wasted a minute trying to make it look neat; perfect working was the sole aim. To furnish uniform motion of his photographic plate a discarded motor-bicycle cylinder was filled with oil and a hole drilled in the piston-head through which the escaping of the oil regulated the speed with an accuracy which sufficed for the most refined quantitative determinations. A sense of proportion characterized all his work. He never wasted effort in securing refinement and accuracy in one part of an experiment which would be nullified by unavoidable errors in another.

The fruits of his work are not measured merely by his own published writings, for Adrian, trained by him in thought and in experimental technique, has followed out some of the ideas suggested by his researches with consummate success. Thus he has established the "all-or-none" law for the nerve impulse; and the far-reaching consequences in physiology of this achievement are expressed in a letter by Professor Sherrington:

> All or nothing as a principle of nerve-fiber response seems to me as to you established. It must

[1] *Proc. Roy. Soc.*, Vol. 85, *B*, p. 495.

[2] *Jour. Physiol.*, Vol. 43, p. 46.

appear as a new datum for whatever schemata we offer of central mechanisms. The data for such schemata have been so few that the diagrams were easy to make but not of much significance. The new ones if less easy to sketch will have more meaning.

Lucas had little patience with unfounded speculation or with the elaboration of hypotheses without any attempt to test them. But that his thoughts were not limited to the direct results of his experiments is shown by his cautious but suggestive remarks on the possible application of his analysis of the Wedensky effect to inhibition in the central nervous system, and again on the possible basis for an explanation of reflex summation. His attitude is expressed in these words:

> There is a tendency to attribute to the central neurone and its connections properties which have no basis in the direct observation of the simple conducting tissues. It is our belief that the time for such a procedure can only come when it has been proved after repeated trial that there is no explanation of central phenomena possible in terms of properties revealed by the study of the simple tissues.

His sense of the immensity of the problems which drew him on is shown in the conclusion of his Croonian Lecture, in which he remarks "we may now claim to have passed through the first phase of ignorance, in which we merely admitted that we did not know, and to have reached the second phase of ignorance, in which we are recognizing what precisely are the points on which our want of knowledge is most profound." The breadth of his outlook on physiology is shown in two stimulating articles on "The Evolution of Animal Function" published in 1909 in *Science Progress*.

Thus he was a scientist combining rare mechanical ingenuity and experimental skill of the highest order with a wonderful grasp of the crucial tests through which advance should come and a broad philosophical view of the truths he brought to light. But besides all this he was a man of great personal charm and nobility of character. His keen and delightful sense of humor and his modest, friendly personality made him a companion and friend beloved by those about him.

The spirit in which he left his absorbing career to play his part in the great fight for liberty is reflected in a letter written in the spring of 1915, an extract of which appears in the *Atlantic Monthly* for October, 1916 (page 546). He was to have joined an artillery company, but on the very day he was to have been sworn in he was sent for to carry on research at the Royal Aircraft Factory on devices for the control of aeroplanes. He had already perfected an aeroplane compass and was engaged in similar experimental work when he met his death in a flying accident.

Alexander Forbes
Harvard Medical School

INDUSTRIAL RESEARCH IN CANADA

The Canadian government has appointed an honorary advisory council on scientific and industrial research to advise a committee of the cabinet consisting of the ministers of trade and commerce, interior, mines, inland revenue, labor and agriculture, on all matters relating to the extension and coordination of scientific and industrial research, with a view to securing united effort and mutual cooperation between scientific workers and industrial concerns, and to selecting the most practical and pressing problems indicated by the industrial necessities for submittal to research and other institutions and individuals for solution.

The members of this advisory council are: Dr. A. Stanley Mackenzie, president of Dalhousie University, Halifax, N. S.; Dr. Frank D. Adams, dean of the faculty of applied science, McGill University; Dr. R. F. Ruttan, professor of chemistry, McGill University, Montreal; Dr. J. C. McLennan, director of the Physical Laboratories, University of Toronto; Dr. A. B. Macallum, president of the Royal Society of Canada, University of Toronto; Dr. Walker Murray, president of the University of Saskatchewan, Saskatoon; Mr. Robert Hobson, president of the Steel Company of Canada, Hamilton, Ont.; Mr. R. G. Ross, consulting electrical engineer, Montreal; and Tancrede Bienvenu, manager of La Banque Provinciale, Montreal.

The question of the cooperation of the scientific men and laboratories of the country with the industrial concerns with a view to solving

the problems raised by the war and to placing the industrial resources of the country in a position to meet the conditions that will arise after the war has been under consideration by the government and by representatives of science and industry for some time, as it was felt that it was more desirable to follow the example of the British government in this matter.

The question was fully discussed at the meetings of the Royal Society of Canada in May, 1916, and a deputation of this society waited upon the Honorable Sir George E. Foster, minister of trade and commerce, and the Honorable Sir Thomas White, minister of finance, to place the services of the society at the disposal of the government and to recommend the appointment of an advisory committee for the furtherance of industrial research. The matter had already been considered by the minister of trade and commerce and action was promised.

Sir George Foster held a number of conferences with representative men of science and industry, and as a result of his report to the government definite action was decided upon in June by order-in-council. In his memorandum he pointed out "the urgent need of organizing, mobilizing and economizing the existing resources of scientific and industrial research in Canada with the purpose of utilizing waste products, discovering new processes —mechanical, chemical and metallurgical— and developing into useful adjuncts to industry and commerce the unused natural resources of Canada."

SCIENTIFIC NOTES AND NEWS

THE president and council of the Royal Society have made the following awards: A Royal Medal to Dr. John Scott Haldane, F.R.S., for his services to chemical physiology, more especially in reference to the chemical changes of respiration. A Royal Medal to Professor Hector Munro Macdonald, F.R.S., for his contributions to mathematical physics. The Copley Medal to Sir James Dewar, F.R.S., for his investigations in physical chemistry, and more especially his researches on the liquefaction of gases. The Rumford Medal to Professor William Henry Bragg, F.R.S., for his researches in X-ray radiation. The Davy Medal to M. le Prof. Henri Louis le Chatelier, For.Mem.R.S., for his researches in chemistry. The Darwin Medal to Professor Yves Delage, for his researches in zoology and botany. The Sylvester Medal to M. Jean Gaston Darboux, For.Mem.R.S., for his contributions to mathematical science. The Hughes Medal to Professor Elihu Thomson for his researches in experimental electricity.

THE Stockholm correspondent of the *Morning Post,* as quoted in *Nature,* states that the Nobel prize for physiology for 1916 will probably be awarded to Professor H. J. Hamburger, of Groningen University. It is stated that the Swedish Academy of Sciences has decided not to award this year the Nobel prizes for physics and chemistry.

PRESENT and former students of Professor E. B. Wilson will give a dinner in his honor in New York on the evening of December 28. Former students of Professor Wilson, whether at Columbia or elsewhere, who have failed to receive an announcement of the dinner, can obtain full particulars by addressing Professor Gary N. Calkins, Columbia University.

PROFESSOR S. A. MITCHELL, director of the Leander McCormick Observatory of the University of Virginia, has been appointed by Columbia University special Ernest Kempton Adams research fellow for a period of five years. This award comes as an extension of the regular Adams fellowship held by Professor Mitchell for the years 1914–16. The research undertaken was the determination of the parallaxes of the fixed stars by photography with the 26-inch McCormick refractor. Already the distances of one hundred stars have been determined.

OWING to ill health, Mr. H. W. Henshaw has resigned his position as chief of the Bureau of Biological Survey, Department of Agriculture, dating from December 1. Mr. Henshaw has been connected with the Department of Agriculture since 1905, serving as assistant chief of the bureau until 1910, and

then as chief. During this period the survey has grown rapidly. In order that the bureau may continue to have the benefit of Mr. Henshaw's knowledge and experience he will retain official connection with it as consulting biologist. Mr. E. W. Nelson, who has been on the scientific staff of the bureau since 1890 and assistant chief since 1914, has been appointed to succeed Mr. Henshaw as chief of the bureau.

As has been already noted in SCIENCE, meetings of the Geological Society of America and the American Paleontological Society will be held in the Education Building, Albany, on December 27, 28 and 29. The address of the president of the Geological Society, Dr. John M. Clarke, is on "The Philosophy of Geology and the Order of Research." That of the president of the Paleontological Society, Dr. Rudolf Ruedemann, is on "Persistent Paleontological Types." There will be public addresses by Dr. George Otis Smith, director of the U. S. Geological Survey, on "Geology and Public Service," and by Professor Richard S. Lull, of Yale University, on "The Pulse of Life." There will be symposia on "The Geology of Petroleum" and on "The Interpretation of Sedimentary Rocks."

THE Section of Agriculture of the American Association for the Advancement of Science will hold its session on the afternoon of December 27, at 2 o'clock, in the Brinckerhoff Theater, Barnard College, Columbia University. At this session the address of the retiring vice-president of the section, Dean Eugene Davenport, of the University of Illinois, will be delivered on the subject of "The Outlook for Agriculture." The subject will be further considered in a symposium on the general topic of "The Adjustment of Science to Practise in Agriculture." This will be presented under the following four heads: (1) Some Factors lying between Scientific Results and the Farm, by Dr. H. J. Wheeler, of Boston; (2) Limitations of Science to Progress in Agriculture, by Dr. J. G. Lipman, director of the New Jersey Experiment Stations; (3) Economic Factors as affecting the Applications of Science, by Dr. G. F. Warren, of the College of Agriculture at Cornell University; and (4) Regional conditions as determining the Type of Agricultural Inquiry, by Director B. Youngblood, of the Texas Experiment Station. The divisions of the subject will be treated in a semi-popular manner, rather than in their strictly technical aspects, and the discussion will not be restricted to any particular department of agricultural science. The purpose is to make the program one of general interest. There will be opportunity for free discussion.

THROUGH the courtesy of the American Museum of Natural History and in connection with the convocation week meetings (December 26–30) of the American Association for the Advancement of Science, the New York sections of the American Chemical Society, chairman, Dr. J. Merritt Matthews; The American Electrochemical Society, chairman, Dr. G. Colin Fink; The Society of Chemical Industry, chairman, Dr. Jerome Alexander; and The Museums of the Peaceful Arts, acting president, Dr. George F. Kunz, are planning an exhibition on preparedness, to be shown on the fourth floor of the museum building. The exhibit will consist of a set of the native elements belonging to the American Museum of Natural History; a collection of all the known elements; electrochemical products, nitrogen products from the air; coal-tar derivatives; and explosives—the new chemistry of preparedness developed during the past two years. The exhibit will be shown during the convocation week and for one month thereafter to the public. Dr. George F. Kunz is chairman of the exhibition committee. Scientific research will be shown in a special exhibit dealing with the life and work of Pasteur. Letters, manuscripts, pictures or other memorabilia which might be of interest in this connection are greatly desired for this purpose. Any one having material that would add to the Pasteur exhibit is requested to communicate with Professor C.-E. A. Winslow, curator of public health, American Museum of Natural History, 77th Street and Central Park West, New York City, who is chairman of this special branch of the committee.

An expedition in the interests of the Smithsonian Institution will leave shortly for the French Congo and certain of the neighboring parts of West Africa. It will be known as the "Collins-Garner Congo Expedition, in the Interests of the Smithsonian Institution," and will be headed by Mr. Alfred M. Collins, of Philadelphia, a well-known explorer and sportsman, who has made several trips to Africa and other regions in search of big game. Richard L. Garner, of New York, who has already made extensive investigations concerning the apes and monkeys of Central Africa, is manager of the expedition. The other members of the party are: Professor Charles W. Furlong, of Boston, scientist, artist and explorer, and Mr. Charles R. W. Aschemeier, of Washington, who represents the Smithsonian Institution as collector of natural history specimens for the United States National Museum. It is expected that Mr. Garner and Mr. Aschemeier will start for Bordeaux as soon as the outfit is ready, probably on December 9, and that Mr. Collins and Professor Furlong will follow about March 1, 1917.

The London *Times* states that a survey party, led by the geologists Messrs. Talbot and Clarke, has been attacked by blacks between Laverton and Warburton ranges, western Australia. Mr. Johnstone, a member of the party, received a severe spear wound in the thigh, and Mr. Talbot was speared through the arm.

Dr. R. Ruggles Gates, who had planned to spend the winter in research work at the New York Botanical Garden, has decided to return shortly to England to enlist in the British army.

Mr. F. A. McLaughlin, instructor in botany at the Massachusetts Agricultural College, has been granted a year's leave of absence for graduate study at the University of Chicago.

The Botanical Society of Washington has elected the following officers for the ensuing year: *President,* Mr. T. H. Kearney; *Vice-president,* Mr. Edgar L. Brown; *Recording Secretary,* Mr. Charles E. Chambliss; *Corresponding Secretary,* Dr. H. L. Shantz; *Treasurer,* Mr. F. R. Farrell. Mr. A. S. Hitchcock was nominated by the society for the position of vice-president of the Washington Academy of Sciences.

The Anthropological Society of Philadelphia has resumed its regular meetings for its fourth year, with Dr. W. Max Müller as president and Mr. E. P. Wilkins as secretary. The society now has twenty members, as follows: R. T. Aitken, G. Annear, B. S. Brumbaugh, D. W. Berkey, E. Chiera, Wm. Churchill, M. M. Dorizas, F. Edgerton, R. H. Ferris, E. W. Hawkes, W. W. Hyde, H. D. Jones, J. E. Mason, W. Max Müller, L. E. Sabary, W. H. Schoff, F. G. Speck, R. J. Weitlaner, E. P. Wilkins, S. Williams. The first meeting of the year was held on November 18, Dr. Müller presenting a paper on "The Humorous Experiences of an Africanist."

Professor John M. Coulter, of the University of Chicago, lectured in the Sigma Xi circuit, including the universities of Kansas and Missouri, from November 13–16. Two lectures were given at each university, the titles being "The Ideals of Science," and "Inheritance and Response."

Dr. Richard C. Cabot, of Boston, is giving a series of lectures under the auspices of the Social Service Corporation of Baltimore, on "The Social Aspects of Public Health Work in the United States," including industrial, educational, moral and religious and governmental aspects.

Professor Heinrich Ries, of the department of geology, Cornell University, is giving a course of ten lectures on non-metallic products in the course on economic geology at Columbia University.

The College of Liberal Arts and Sciences of the University of Illinois has announced a series of assemblies for 1916–17 that will consider recent developments in science. On last Thursday evening the first of these was held, at which Professor Joel Stebbins spoke on "Measuring the Light of Stars." The second will be held on December 14, the speaker of the occasion being Professor Jacob Kunz, who will speak on "Recent Light on the Ultimate Constitution of Matter." The third, January 11,

will be addressed by Professor R. C. Tolman on "The Theory of Relativity." The fourth, February 15, will be addressed by Professor C. S. Hottes on "Some Recent Advances in the Physiology of the Cell" and the fifth on March 15, will be addressed by Professor G. M. Whipple on "Recent Development in Mental Testing." The speakers are all from the University of Illinois.

THE following lectures were recently given at Oberlin College, under the auspices of the department of zoology: "The Maturation and Fertilization of the Eggs of *Nereis*," by Dr. Omer Van der Stricht, of the University of Ghent (now at Western Reserve University, Cleveland); and "The Significance of the Egyptian Mummy," by Professor T. Wingate Todd, head of the department of anatomy at Western Reserve University Medical School.

AT the Lowell Institute (Boston), on Tuesday and Friday evenings beginning Tuesday, December 5, a course of six lectures is being given by George Sarton, D.Sc., editor of *Isis* and lecturer on the history and philosophy of science at Harvard University. The course is on science and civilization in the time of Leonardo da Vinci, the titles of the lectures being:

1. "The Age of Leonardo."
2. "The Place of the Earth in the Universe."
3. "Geographical Discoveries."
4. "Progress in Physics and Chemistry."
5. "Progress in Biology and Medicine."
6. "The New Humanism."

FIVE lectures will be given at the Royal College of Surgeons of England in December by Dr. E. Mellanby, acting superintendent of the Brown Animal Sanatory Institution, on the part played in disease by water, salts and other simple substances.

THE Swiney Lectures on Geology on "The Mineral Resources of Europe" have been delivered by Dr. J. S. Flett, at the Royal Society of Arts, London.

THE Kelvin lecture was delivered before the Institution of Electrical Engineers, London, on November 9 by Dr. Alexander Russell, who explained how, in many fields of fundamental importance to the electrical engineer, Lord Kelvin's work had provided the basis on which his successors had built.

FREDERICK J. HAMILTON MERRILL, director of the New York State Museum from 1894 to 1904 and New York state geologist from 1899 to 1904, later a consulting geologist and mining expert in New York City, Arizona and California, died in Los Angeles on November 29, in his fifty-fifth year.

NEWTON B. PIERCE, formerly plant pathologist for the U. S. government for the Pacific coast region, and more recently private collector and breeder of rare plants, died at his home in Santa Ana, Calif., the thirteenth of last October, aged sixty years.

SIR HIRAM STEVENS MAXIM, the distinguished inventor, died in England on November 24.

MR. CHARLES SMITH, master of Sidney Sussex College, Cambridge and the author of works on mathematics, died on November 13, at the age of seventy-two years.

PROFESSOR H. M. WAYNFORTH, until recently professor of engineering in King's College, London, died on November 5, aged forty-nine years.

HENRIK MOHN, the distinguished Norwegian meteorologist, died on September 12 at Christiania, aged eighty-one years.

MEMBERS of Section E, Geology and Geography, of the American Association for the Advancement of Science, are requested to forward titles and abstracts of papers to be read at the New York meeting, to Dr. George F. Kay, Iowa City, Ia., not later than December 12.

THE Sullivant Moss Society will hold its twelfth meeting on Friday, December 29, at Barnard College, Columbia University, in connection with the convocation-week meetings of the American Association for the Advancement of Science.

UNIVERSITY AND EDUCATIONAL NEWS

GOVERNOR EDWARD F. DUNNE and Dr. S. W. Stratton, director of the Bureau of Standards, are among the speakers that will give addresses on the occasion of the dedication of the new ceramics building at the University of

Illinois on December 6 and 7. Partly in connection with the exercises of the dedication of the new ceramics building, there will be held the annual session of the Illinois Municipal League, the 7th and 8th of December. University men giving addresses at this meeting will be Professor F. H. Newell, who speaks on "City Pavements"; Professor Edward Barton, on "The Latest Methods of Sewage Treatment"; Professor J. E. Smith on "Delays in the Execution of Public Works"; H. E. Babbitt on "Organization of Water Departments," and Professor J. M. Mathews on "Law Enforcement and Home Rule."

MRS. W. L. MARDSEN, of Seneca, Oregon, has given to the University of California extensive texts, grammatical notes and a vocabulary of the northern Piute language, recorded by her husband, the late Dr. W. L. Marsden. It is intended that these materials shall be edited by Professor A. L. Kroeber, for publication in the University of California publications in American archeology and ethnology.

WE learn from the *Journal* of the American Medical Association that Nielsine Nelson, the first woman physician in Denmark, bequeathed to the medical faculty of the University of Copenhagen three funds of 20,000 crowns each for scholarships for needy women medical students, and a further 50,000 crowns for the same purpose in the name of Ludvig Trier, a friend who had aided her and other students.

DR. GEORGE E. VINCENT, president of the University of Minnesota, has been appointed president of the Rockefeller Foundation, and will take up this work on May 15, 1917. He succeeds Mr. John D. Rockefeller, Jr., who will become chairman of the board of trustees, a newly created office. It will be remembered that Mr. Jerome D. Greene recently resigned the secretaryship of the board.

PROFESSOR ERNEST LINWOOD WALKER, of the University of the Philippines, has been appointed a lecturer on tropical medicine at the Harvard Medical School.

MR. W. L. DORAN, for the last two years graduate assistant in botany at the Massachusetts Agricultural College, has been appointed instructor in botany and assistant botanist at the New Hampshire Agricultural College and Experiment Station.

DR. ROY G. HOSKINS has been appointed associate professor of physiology in the Northwestern University Medical School.

DISCUSSION AND CORRESPONDENCE

OBSERVATIONS OF THE AURORA OF AUGUST 26 FROM BRITISH COLUMBIA AND ALASKA

SINCE the auroral display of August 26 has been reported from so many places I will take occasion to slightly extend the area over which it was observed by advising that it was a very conspicuous feature of the northern sky at Victoria, Vancouver Island, British Columbia. It was therefore observed from Atlantic to Pacific.

KAY ALEXANDER

November 15, 1916

I HAD an unusual opportunity for observing the auroral display of August 26, being at that time camped on the recently discovered Mount Alexander Mackenzie, on the crest of the Rockies of British Columbia in latitude 53° 57′, longitude 120° 27′.

Auroral displays are not unusual in this region even in summer, but the phenomenon of August 26 was by far the most brilliant and remarkable I have observed. It occurred at a very opportune time for me, as I was then returning after an exploration of the great west glacier. I got off the ice at 7:45 P.M., as the last rays of twilight faded; as I had still three miles to travel to camp, including the crossing of a steep 2,000 foot canyon, I was facing a chilly night under the stars, when quite suddenly the whole heavens became brilliantly illuminated and I was thus enabled to make the difficult climb back to camp.

The display began about 8:30 P.M. Pacific (120th meridian) time, with the formation of a bow of light in the north, surmounting a dark area which suggested the Crookes dark space in a vacuum tube. This increased in brilliancy and was supplemented by other irregular bows or bands of light, crossing the sky from east to west. These were the principal

sources of brilliant illumination, but in addition the whole sky, almost to the southern horizon, was swept with darting and shimmering beams and shafts and curtains of light.

I shall not attempt to rival the vivid description of Professor Nutting, for words fail to express the wonderful beauty and complexity of the display. One of the most striking features was the weaving of curtains of light, appearing as if composed of parallel shafts or filaments, which brightened and paled in waves passing sometimes in one direction and sometimes in the other. These waving curtains interweaved in the most marvellous fashion, sometimes two or even three distinct and overlapping motions being visible in the same area, the shafts of light appearing to glide to and fro like the figures in a complicated but tremendously silent dance.

A little later the display took on the most varied colors, though this phase of the phenomenon was comparatively brief.

The display ceased suddenly at about 9:45 P.M., just as I reached camp. Some of the bands were so brilliant and stable that I determined to try to photograph them. I went into the tent to get my camera and tripod and when I emerged not five minutes later the sky was nearly dark. FRED K. VREELAND

NEW YORK CITY,
November 15, 1916

IT has seemed odd to me, a layman, that no scientist has yet reported to you the far western occurrence of the remarkable auroral display of August 26 last.

One year spent at Rampart on the Yukon about thirty-five miles south of the Arctic Circle had made me familiar with the varied manifestations of the aurora, its marvelously brilliant colors and the crepitation which occasionally accompanied them.

On August 26 I was hunting brown bear near Spass Kaia Bay on Chichagoff Island W. of 136° Long. and N. of 58° Lat. About 7:30 P.M. as nearly as I could guess, my attention was attracted by auroral streamers near the horizon. Looking up to the zenith the whole sky in every quarter was flooded and suffused with one of the most vivid and brilliant displays I have ever seen. The play of the glow and of the streamers was as rapid as that of heat lightning. The colors seemed to be of every shade of the spectrum. The play of the colors was the most remarkable manifestation to my mind, for they would alternately appear and disappear, the same streamer being full colored at one instant, gray and colorless the next, and colored full again. It is unusual to have so general and so vivid a display so far south even in Alaska, and the natives commented on the fact, saying it was a very rare occurrence and a sure sign of early sharp frost and winter. ERASTUS BRAINERD

SEATTLE, WASH.,
November 21, 1916

I WISH to add one more report to the long list already published, relating to the aurora of August 26. I was in Glacier Bay, Alaska, at the time, and saw a marvelous display on that evening. It began shortly after sunset, between eight and nine, Alaska time, when there was still considerable daylight in the sky. In its first appearance it was a sinuous band composed of pale green lances of light, seen first in the east, and winding over toward the west, fading into the still bright sunset light. This was shortly duplicated farther to the north; then four such bands were seen at once. Later, various colors appeared in rapidly changing sheets, working toward the zenith. The climax came with a great burst of color directly above us, almost like an explosion, but remaining in full brilliancy for at least some minutes, constantly changing with marvelous rapidity. The colors included purples, heliotrope, pink, light and dark green. This burst faded away, then repeated itself, and faded again. During the remainder of the evening the lights were pale and diffuse.

I have tried to deduce some general conclusions from the numerous reports that have appeared, with the following results. The aurora was visible over the whole of the northern two thirds of North America, the farthest stations reporting being Nova Scotia, Washington, D. C., Nebraska, Portland, Oregon and Glacier Bay. Plotting these stations on the

map, with whatever data concerning brilliancy and colors are available, the conclusion seems plain that the northern stations across the continent show the most variety in color. Reports from northern Michigan, Hector, B. C., and Glacier Bay indicate brilliant and varied colors, and these are the farthest north of stations reporting in their respective longitudes. Four others report less striking color effects: Ephraim, Wis., Lake Minnetonka, Minn., Beartooth Mts., Mont., and possibly Teton Co., Mont.; and all of these speak of pink or rose. All of those reporting from farther south mention or imply lack of color except the usual pale green. It appears therefore that variety of coloring increased northward. Another interesting point is that the display began everywhere at approximately the same hour, local time: that is, in the neighborhood of eight or nine P.M., or soon after sunset. Apparently then it moved westward across the continent, though it is barely possible that it merely became visible in each case with oncoming darkness. One or two of those reporting mention a streaming movement from east to west, which may or may not be of importance.

It is perhaps worth mentioning that during the week following August 26 two other auroras were visible, on August 30 and September 2. The latter was a very fine one—a bright greenish glow covering the whole northern sky almost to the zenith.

WILLIAM S. COOPER

MINNEAPOLIS, MINN.,
November 16, 1916

IT seems worth while to place on record the fact that the auroral display of August 26, 1916, recorded in so many parts of the continent, was especially brilliant at Juneau, Alaska. I noted it from about eight until after ten P.M. and was told by others that it continued until nearly midnight. It was the first one that I noted last summer, but I can not recall any of its details except that it was one of unusual brilliancy.

ALFRED H. BROOKS

WASHINGTON, D. C.,
November 13, 1916

I HAVE read with great interest, in the issues of October 20 and November 10, the letters recording the auroral display of August 26. I notice that the most western record, as given in SCIENCE, is from Collins, Washington, and the most northern one, in western North America, from the Selkirk Range in British Columbia. It may interest you to know that the auroral display on August 26 was a most magnificent one on the coast of Alaska. I was at the time a few miles south of Skagway, Alaska, and had an opportunity to witness the phenomenon in all its splendor. The display of all the colors of the spectrum rushing together from all directions into a gigantic whirlpool in zenith and then dispersing, lasted for at least half an hour. I may add that for a few days before the auroral display the electric conditions in the air were such as to render it almost impossible to use wireless telegraphy between points in Yukon and Alaska.

My colleague, Mr. H. T. Gussow, Dominion botanist, informs me that he witnessed a most brilliant auroral display on the 26th of August in the Straits of Georgia, between Vancouver Island and the mainland of British Columbia.

M. O. MALTE

CENTRAL EXPERIMENTAL FARM,
OTTAWA, CANADA,
November 13, 1916

THE AURORAS OF 1859

So much has been said about the aurora of August 26 of this year that I have been thinking it might be well to make a note on the similar displays of August 28 and September 1, 1859, which few of the present readers of SCIENCE probably saw, but which seem to have been more splendid and remarkable. In both of these the streamers covered the whole sky, north and south, east and west, as seen from the Atlantic coast, in about latitude 43, where the present writer was then located, and converged to a point south and a little east of the zenith, indicating that they were in fact parallel to the dipping compass needle, the variation of which was a little west, for the north end.

In the display of August 28, they were of various colors; in that of September 1 they were of a uniform red. The brightness seemed to be about the same in both cases, and sufficient for one to read a printed page with ease. There was no moon. The southern streamers, especially, were very changeable; having continually many of what were then called "merry dancers," or rapidly changing clouds of light, among them. These displays, as it was noticed in the papers at the time, were visible as far south as Cuba; though of course they were not there so brilliant. They were accompanied by magnetic storms, and interference with telegraphic work.

The present writer was then engaged in astronomical observations, which had to be suspended during these illuminations.

Geo. M. Searle

Apostolic Mission House,
Brookland P. O., Washington, D. C.

INFERENCES CONCERNING AURORAS

To the Editor of Science: I was much interested in the vivid description of the aurora of August 26 given by Dr. C. C. Nutting, followed as it was in the next issue of Science by a number of letters from different localities concerning the same, and I find in the last issue of Science, that of November 17, a most interesting account of this aurora, with general considerations respecting this phenomenon, given by Professor C. C. Trowbridge, of Columbia University.

Inasmuch as I had some time ago prepared a paper entitled "Inferences Concerning Auroras" for presentation at the meeting of the National Academy of Sciences in Boston, where the paper was read on November 14, it may be of interest to make a few brief statements concerning the inferences presented. In an address at the opening of the Palmer Laboratory of Physics at Princeton, entitled "Atmospheric Electricity" which appears in Science, N. S., Vol. 30, No. 781, pp. 857–869, December 17, 1909, I took occasion to state some opinions based upon the observation of auroras for many years, particularly as to the general relation of the auroral streamers to the earth. I quote the following statement:

> I have come to the opinion that the auroral streamers often extend in a general direction outwardly from the earth, sometimes for very great distances relatively to the known extent of our atmosphere. The effects observed appear unaccountable on any other supposition, while they are consistent with the idea of outwardly directed streams of great extent.

The evidence furnished by the recent aurora of August 26 confirmed the inferences which I had made many years ago, and added considerably to the possibility of applying certain ideas in explanation of auroral phenomena generally. In the paper before the National Academy I have, I think, established with a fair degree of certainty that the auroral streamers are in reality vertical or approximately vertical to the earth's surface. These vertical streamers appear in bands, more or less wide, in the general direction of parallels of latitude forming belts or zones in which the streamers extend upward, somewhat like trees in a forest. I find an explanation, also, of those auroras which appear to be limited to a narrow belt, and appear as a single narrow streak of light across the sky from east to west. There may be, of course, in any aurora, a number of such belts occupying different latitudes. I have endeavored to show, and I think successfully, that the curvature of the so-called auroral arch is a purely optical effect of perspective, increased somewhat by the curvature of the earth, and that the appearance of folded curtains of streamers merely means that the lower ends or feet of the streamers which are, with relation to the observer, of varying altitude, or are of varying latitude as in a belt which is of a winding nature.

It is pointed out, also, that the convergence of long streamers towards the zenith seen in the great auroras is purely an optical effect of perspective, and that the so-called zenith crown is, in reality, due to bundles of streamers nearly vertical like the others, but seen on end overhead.

There are a number of other inferences which are supported by the observations of Carl Störmer and others, among which is the probable existence of a conducting layer at a

height approximately fifty miles above the earth's surface.

It is expected that my paper will soon be published in the *Proceedings* of the National Academy of Sciences. In it the arguments are presented in full.

ELIHU THOMSON

A BUSINESS MAN'S APPRAISEMENT OF BIOLOGY

THE erection and dedication during recent months of important additions to the physical being of the Scripps Institution for Biological Research of the University of California has brought the name of the chief donor of money, Miss E. B. Scripps, quite conspicuously to public notice. Indeed so exclusively has the growth of the institution seemed in the eyes of the community to be the work of Miss Scripps that a brief statement of what has actually been and is going on here appears almost imperative not only to her but to all who have the welfare of the enterprise at heart.

In what follows I speak primarily in the interest of a department of the University of the State of California, the purpose of which is to investigate nature for the general good, and only secondarily in the interest of the particular persons who will figure in my remarks.

One of the most important secondary services a scientific research institution can render the public is in demonstrating that specialized and disciplined talent for studying nature, business experience and skill, and material wealth must be and can be brought together for the great task of making nature yield its best to the development of man's latent physical and spiritual capacities. A point needing emphasis just now is that no one who has grasped the full meaning of the task, and has had actual experience in it, can possibly raise the question as to which of these three factors is all-important—which is the "real thing" in the undertaking. All are absolutely indispensable, and debate on which is most important is scholastic folly. The reason for these remarks is the circumstance that the temper of the day makes the wealth factor appear to most eyes as the main one, the determining one, the one to which all the others are secondary. The prevalent theory that, after all, he who "holds the purse strings" is the real "power behind the throne" even in educational and scientific institutions, and so is the one to whom homage is chiefly due, is an embryonic trait, as biologists say, in the development of civilization —a trait to be left behind with advance toward adulthood. No one understands this better than do some of those who give large sums of money to public institutions. It does not disparage by one whit the importance of having large wealth and being willing to devote portions of it to the general good to point out that, as everybody knows who is acquainted with Miss Scripps, nothing could be more alien to her nature than to glory in the mere giving of a large sum of money toward the creation of an impressive physical structure dedicated to public use. Evidence that an "investment," be it large or small, contributes substantially to the general welfare, would give her supreme satisfaction, as this would be evidence not of mere ability to give, but to give *wisely*. In how far satisfaction of this sort is coming to Miss Scripps for what she has invested in this enterprise I do not know. I suspect there is still uncertainty in her mind; for the institution is too young to enable her to judge what service it may render.

But the personage primarily in view in this communication is not Miss E. B. Scripps, but Mr. E. W. Scripps. The truth is I am taking it for granted that Miss Scripps recognizes now the desirability of a kind of publicity concerning the origin and aims of the Scripps Institution not hitherto furnished, and that she would be willing to have me use her conception of an "investor" in behalf of the public as a starting point for what I am going to say about her brother. My words are addressed first and foremost to men of science, especially those who reflect on the larger human significance of material knowledge and the discovery of it.

The narration of a bit of personal-professional experience will be permissible, since it

will help to the end aimed at. Whether the Scripps Institution shall or shall not turn out to be useful to mankind, the foundational motive upon which it rests is a faith in the value of science, especially biological science, far more concrete and deep and broad than that which seems to be held by most men of science; and *this is in large measure due to E. W. Scripps*. I must explain. By native inclination the study of nature understood in much the sense of "the contemplation of nature" favored by naturalists a few generations ago, is to me one of the most exalting occupations the human mind can have. During the early part of my apprenticeship in science this feeling found great encouragement through the teachings and life of Joseph Le Conte, with whom at the University of California I came, as student and later as teacher, into close contact. Then there was a period of that intense specialization indispensable to progress in modern science, and with it the narrowing of interest and outlook and sympathy so likely to accompany such specialization. It was in this period of intensified specialization and concomitantly narrowed horizon that the early stages of development of the marine biological work which led to the present institution fell; and it was also in this period that my acquaintance with Mr. Scripps began. I saw him first in the summer of 1903, and the circumstances of the meeting were typical of my whole association with him. Our "marine laboratory" that year was a portion of the boat house on Glorietta Bite, Coronado, this space having been generously given us by the Coronado Beach Company. Mr. Scripps came on purpose to see what was going on, and the thing that especially struck me was his lively, pushing, obviously sincere interest in the details of our work. His visit was no mere hasty, listless walk through the room with a few more or less relevant remarks designed primarily to tell us in the least offensive way possible how really insignificant the whole thing was in his eyes. But with a sort of child-like eagerness he insisted upon being shown something about what each of the half dozen workers was doing. Here indeed was "something new under the sun"—at least to me. A man who, though the central figure in a great business, could yet drive twenty miles to visit a puny little scientific establishment and, though an entire stranger to such a place, could show an interest in not merely the enterprise but the actual work that was obviously genuine and, as to broad features, remarkably intelligent!

A part of my regular duty for a number of years had been to solicit private funds for our struggling enterprise and I had succeeded to some extent in interesting several men of large means in certain aspects of it, chiefly, perhaps, that of how to "let me down" with a minimum of disappointment to me and cost to them. But a few of these men had gone well beyond this and had shown real interest in the general idea of a marine laboratory and had done considerable work and promised to give substantial sums toward accomplishing the end. But never before had I found an interest that was not merely in the general idea or in me personally or professionally, but in science—in biology—*as such*.

Through the intervening years of association with Mr. Scripps, much of the time in the most intimate way, even as to the scientific work of the undertaking, not only have I never heard him so much as hint that any fragment of scientific knowledge or piece of research might be valueless, but his whole attitude and not infrequently his expression have been that of recognition of the inherent worth and dignity of natural knowledge, and most of all, of faith in science, especially, again, in biology, as the very foundation of rational human life in modern society. No scientific man, LeConte possibly excepted, with whom I have ever come in contact, has had so broad, so deep, so unfaltering and withal so intelligent a belief in the greatness and human worth of science, as Mr. Scripps.

Such a conception of nature, and of science as the rational interpretation of nature, held by a man endowed by birth with very unusual powers of mind, but, academically speaking, quite undisciplined in science, and eminently successful in business, has influenced my

thinking and estimates of value during the last decade beyond anything I can here tell. Enough to say that the scientific inquiry which has long been in the forefront of my interest, that namely of what the *real constitution of nature must be in order that it may include man in the full scope of his being,* has become wonderfully specific and real by having this remarkable subject under almost constant observation for so long a period. This perhaps more than any one factor has led me to conclude that the system of nature is, as by instinct almost Mr. Scripps appears to take it, much more intimately and vitally related to man than our modern philosophy or even our science usually recognizes.

Science has made great headway latterly in proving that man is a *part of nature;* but it has not done much toward understanding what nature is *because* man is a part of it.

The exceedingly unfortunate doctrine into which so much of western civilization has fallen, that everything about man which is esteemed supremely good is no part of his real nature but is supernatural (teaching of Christian theology) or is a by-product, an "epiphenomenon" (teaching of neo-Darwinian biology) nowhere finds more positive refutation than in such individuals as Mr. Scripps, whether we observe them as types of organic beings or consider their views about nature and science.

Such reflections have led me to endorse heartily his views that the human species taken exactly as it is and in the entire scope of its life, must be a subject for biological study; and to share his ambitions and intentions that the Scripps Institution shall after a while make some aspect of human biology thus conceived one of its departments of research. Those transcendent concerns of civilized man, the relation between the sexes, war, economics, patriotism, government, esthetics, ethics and religion, can never be treated with that freedom from prejudice and personal interest by which alone general truths can be rightly understood and appraised, excepting through the attainment of that attitude toward the tasks which characterizes the biologist in his dealing with problems of organisms inferior to man. This at least is the conviction we have reached after wide observation of instances and much theoretical discussion. And why in the nature of things should it not be possible to reach such an attitude toward the purely rational aspects of human problems? If man really is a part of nature, as biology confidently affirms that he is, how escape recognizing that if a bird's nest is a proper object for biological inquiry, an Eskimo's snow hut and a millionaire's palace are also? Or that if the mating antics of two spiders are biological phenomena, the Virginia reel and the tango are likewise? Or that if a bird chorus on a spring morning falls within the province of ornithological biology, a symphony concert falls within the province of anthropological biology? And it should be specially noticed that the fact that each of these sets of phenomena falls within the province of general biology does not by any means remove them from more restricted and specialized inquiry. The general biologist whose studies lead him to birds' nests or the courtship of spiders or the song of birds, not only is not disposed to supplant specialists in these subjects, but is led to recognize more than ever the importance and indispensability of their labors. Just as the general biologist who should come upon the subjects of social wasps or singing birds, could not do much without the help of specialists in these subjects, so the biologist who upon occasion should turn to social or musical humans, would be almost helpless without the aid of experts in human society and human music.

Much as we believe in the utility of biology to industry, hygiene, eugenics and the rest of man's material welfare, a thousand times more do we believe in its utility to his higher interests, especially just now when "Christian civilization" seems bent upon putting into practise the monstrously perverted biological theory of survival of the fittest, and destroying itself through military and economic war.

Concerning what Mr. Scripps's business experience and acumen have meant for the physical development of the institution, I will be

specific only with reference to two matters. First, that of the location of the institution. The idea of getting the present 177-acre site and of using it as it is being used originated with him and with him alone; and securing the land would have been impossible without him. But for his leadership in this we should now be in the little three-acre park in La Jolla. The enormous advantage of the present location as compared with the former one is becoming apparent to everybody connected with the institution. Second, the plan of having a business manager who alone should have charge of all monetary affairs of the institution. The wisdom and practicability of separating the business and scientific work of such an enterprise would seem so obvious that it is surprising that any other plan should be thought of except as a temporary makeshift. Yet the time and strength of many scientific men are consumed with business matters which their incompetence makes much more costly in time and money than the employment of a business manager would be.

The money, about $40,000 all told, "invested" in the enterprise by Mr. Scripps, though of very substantial aid in developing the "plant" and in maintenance, for which uses it has been given at different times and in varying sums, is of minor importance compared with the business experience and the ideas which he has contributed.

Wm. E. Ritter

Scripps Institution for Biological Research of the University of California, La Jolla, Calif.

PSYCHOLOGY AS CONTRABAND

To the Editor of Science: Some weeks ago the State Department reported the seizure by the British government of a package of books sent from Germany through Holland to the Psychological Review Company. The president of the company, who is also editor of the *Psychological Review*, wrote to the American Consul General at London, stating that these books were scientific in character and essentially neutral. He suggested that the British authorities mention the titles and authors to any British psychologist and expressed confidence that any such expert would substantiate our statement.

The Consul General in due time replied that the British Procurator General had finally ruled that "such publications were not entitled to free transit."

The *Psychological Review* will not contest this decision in the British courts, but we wish to submit our case to the scientific world at home and abroad. Is there any good reason for hampering scientific progress by a policy of this sort? Would not the British psychologists do well to petition for a commission to determine the mental status of their Procurator General?

Howard C. Warren

Psychological Review Company, Princeton, N. J., November 15, 1916

QUOTATIONS

FOOD CONTROL

The decision of the board of trade, announced by Mr. Runciman on November 15, to appoint a food controller, has naturally excited a great deal of public interest, and more has been read into the announcement than it actually contained. The orders so far made by the board of trade under the Defence of the Realm Regulations apply to milk, flour and potatoes. The price of milk must not be raised above that paid at November 15, 1916, and the price may not exceed by more than a specified amount—in the case of retail milk 2d. a quart—the price in the corresponding month before the war. The order as to potatoes requires a return of potato stocks. The order which will have most effect in its influence on our daily diet is that which deals with flour. It affords an instance of how an agitation, unsuccessful in peace time, may succeed in its object under the stress of war conditions. The severe restriction of the hours during which alcoholic liquors may be sold, and the introduction of "summer time," or daylight saving, as it has been called, are other examples. The regulation prohibits for the future the production of any flour except such as would have been

called a few years ago, when there was a considerable agitation for its adoption, "standard flour."

The relative advantages and disadvantages of the grinding of wheat so as to produce a flour containing a larger proportion of germ and bran than the ordinary white flour have been somewhat fully discussed in our columns. The prevalent method, in consequence of the preference of the public for a very white flour and very white bread, has been to grind the wheat and separate the product into a succession of fractions, the principal fraction, white flour, forming about 70 per cent. of the grain. By arranging the milling in such a way that 80 per cent. instead of 70 is collected in one fraction, the amount of protein in the flour is substantially increased, and it has been claimed that the product is increased in nutritive value not only by the enhanced amount of protein, but by the retention in it of a larger proportion of the vitamines of the embryo. Mr. Runciman appears to have been impressed by this view of the matter as well as by the advantage of getting an additional yield. He stated in the House of Commons that the government had decided that 70 per cent. flour can not now be permitted in this country. "Pure white flour," he said, "from which has been abstracted, as some people think, some of its most valuable qualities, will not be milled in future. We shall retain in the flour a good deal of what I believe in some quarters is called offal and in others precious food." He went on to state that the percentage of wheat which should be converted into flour varied with different kinds of wheat, and that a scale of percentages would be laid down which would, on an average, raise the yield of flour about 8½ per cent. The milling order which has since been published gives the percentage of flour that must be extracted from wheat as varying from 73 to 78 per cent. according to the variety, the highest figure being that for Australian wheat; the average figure is 75 per cent., which is still well below the 80 per cent. which was the percentage adopted for giving "standard flour." Even the additional 5 per cent., however, represents a large increase in the amount of flour obtained from every sack of wheat. The palatability of the resulting bread will continue to depend chiefly on a judicious blending of flours and on good baking.

While there may still be some difference of opinion as to the extent of the advantage secured, there will probably be no difference of opinion in the medical profession on the point that it will, in the existing circumstances of the food market, be considerable, even apart from the fact that a given amount of wheat will yield a much larger proportion of bread than before. In this case, as in the case of "summer time" and other innovations, it will be interesting to see whether the general experience obtained will lead to the retention after the end of the war of what has been adopted as a temporary measure.—*British Medical Journal.*

THE decision of the government, which appears likely to result in the general consumption of "standard bread," will no doubt be received with varied feelings by various sections of the community. In view of the certainty that such differences of opinion are likely to arise, the following brief sketch of the facts of the case so far as they are known may be of general interest.

Under normal conditions at the present time the average practise of roller milling results in the recovery from cleaned wheat of rather more than 70 per cent. of its weight of flour, the remaining 28 or 29 per cent. of the wheat, consisting of various grades of "offals," being sold for feeding stock.

The changes announced last week would make it compulsory to recover 80 per cent. of flour from wheat, which would increase the amount of flour by about 8½ per cent. and decrease the amount of offals for stock-feeding by a like proportion, the percentage in both cases being calculated on the amount of cleaned wheat available for milling.

On the basis of the amount of flour produced in the United Kingdom for home consumption in the years immediately before the war, the change announced would increase the amount of flour available for bread-making by very nearly 600,000 tons, which would provide an extra 2-lb. loaf for every inhabitant of the

United Kingdom every three weeks, or seventeen extra 2-lb. loaves per head of the population per year. This is by no means a negligible increase in the bread supply, and it is doubtless considerations of this kind that have induced the government to take action.

If, however, we examine the result rather more closely, we find that the increase in the nation's food supply may not be so great as the above figures indicate. In spite of repeated statements to the contrary, bread made from 80 per cent. flour is not so nutritious, weight for weight, as bread made from 70 per cent. flour—at any rate, for the supply of protein and energy for the general population. Although 80 per cent. bread contains on the average rather more protein than 70 per cent. bread, the digestibility of the protein in the former is rather lower, so that the actual weight of protein digested by the average individual from 1 lb. of 80 per cent. bread is rather less than the amount digested from 1 lb. of 70 per cent. bread. Again, the energy value of 80 per cent. bread is rather lower than that of 70 per cent. bread. Still one more correction must be made in order to arrive at the actual increase in the national food supply which will result from the general adoption of a milling standard of 80 per cent. It is pointed out above that the recovery of 80 per cent. of flour from cleaned wheat entails a decrease in the supply of the finer wheat offals for stock-feeding to the extent of about 600,000 tons. These finer offals are largely used for feeding pigs. Their transference to human consumption would therefore decrease the production of pork and bacon, and this must be allowed for in estimating the total effect of the proposed alterations in milling. After applying all these corrections it appears that the general adoption of an 80 per cent. standard would undoubtedly give a substantial increase in the amount of digestible food for the supply of protein and energy for the population of the United Kingdom.

The possibility that the food value of bread would be substantially increased by the adoption of the 80 per cent. standard, because the content of the mysterious constituents known as vitamines would be increased by the inclusion of a greater proportion of the germ and of the outer layers of the grain, is perhaps scarcely worth discussing in this connection. Such constituents are supplied by other items comprised in an ordinary mixed diet, so that the vitamine content of bread can have little practical significance except in the very few cases where bread forms the whole, or very nearly the whole, of the diet.

The price of wheat offals for feeding stock is now so high that the adoption of the 80 per cent. standard can not be expected to make any considerable reduction in the price of bread. Even the compulsory admixture of a considerable proportion of other cereals, such as maize, oats or barley, with wheat for bread-making would not greatly cheapen the loaf, because these cereals are not very much cheaper than wheat. The important point in raising the milling standard and in including other cereals among the breadstuffs is that it would widen the sources from which the national food supply is derived—a most desirable end under existing conditions. To summarize, the result of a compulsory 80 per cent. standard would be neither better bread nor cheaper bread, but more bread.—*Nature.*

SCIENTIFIC BOOKS

The History of Melanesian Society. By W. H. R. RIVERS. Cambridge: The University Press, 1914. 2 vols. Pp. xii + 400 + 610.

Ethnologists have learned to rejoice at the sight of Dr. Rivers's name on the title page of an ethnological monograph. His work among the islanders of the Torres Straits stands as a model of painstaking research and critical method, originated in part by Dr. Rivers himself, while his elaborate study of the Todas of Southern India ranks with the best descriptive monographs of modern ethnology. In view of the author's methodological labors, moreover, one's anticipations are kindled as he glances through the pages of this newest attempt to reconstruct and interpret the history of an ethnographic district of which the cultural complexities have already taxed the ingenuity of Thilenius and

von Luschan, of Leo Frobenius, Graebner and Churchill.

The first volume of the book is wholly descriptive. It brings new data on the material culture and art, religion, ceremonial and social organization of several of the island groups of Melanesia. The data on social organization are particularly welcome, for they fill a long felt gap; unfortunately the author's own material also falls far short of being exhaustive; many details of the social systems described are lacking, nor are even the fundamentals always as definite as might be desired. Dr. Rivers, moreover, himself characterizes the descriptive part of his book not as an exhaustive treatise but rather as a preliminary survey. Further contributions covering the field are already announced: a volume on the Western Solomon Islands by Mr. A. M. Hocart and the author and a monograph by Mr. G. C. Wheeler on the islands of Bougainville Straits. Only one phase of his subject has Dr. Rivers covered almost exhaustively, the systems and terms of relationship together with the behavior of relatives. A valuable comparative list of terms used in the different island groups is appended to the first volume.

Of far greater significance and general interest is volume II. In it the author attempts a systematic albeit speculative reconstruction of Melanesian history. Whatever one may think of the author's conclusions, or even of his method, he deserves the highest credit for having conceived and carried out a logically coherent theoretical argument, at the hand of a multiplicity of concrete data, an argument which fills more than five hundred pages and, as an intellectual effort, stands unique in the whole range of ethnological literature.

In the first part of the volume the author uses the time-honored evolutionary method of historic reconstruction based on the theory of survivals. The fundamental assumption made by the author, which he uses as the cornerstone of the entire argument, is the basic and permanent character of social organization. This assumption is supplemented by the theory that the terms of relationship directly and faithfully reflect the social structure, particularly the forms of marriage. Operating with these hypothetical tools the author examines the morphology of the relationship systems of Melanesia and arguing from these to forms of social organization, particularly of marriage, he arrives at the earliest form (for the purposes of his argument, at least) of Melanesian society, characterized by a dual organization, maternal institutions, and a communism associated with a gerontocracy, the rule of old men, who tended to monopolize the women of the group and wielded undisputed authority in tribal affairs. During that remote period individual marriage gradually came into being and the relations of father and child became for the first time clearly defined. By argumentative steps which space forbids us to follow the author proceeds to carry Melanesian society through later stages, among these a totemic one, which, however, in some parts at least of Melanesia later again disappears, leaving no traces of its former existence.

The next move is a linguistic reexamination of the relationship terms of Melanesia, the result of which is a complete reinterpretation of the evolutionary process outlined above. For the author's comparative survey reveals two sets of terms: one set is very much the same linguistically in the whole of Melanesia, the other varies as one passes from island group to island group. The conclusion is that the uniform terms must belong to an ancient indigenous population, the diversified ones to a later people of immigrant origin. Thus is reached the conception of the cultural complexity of Melanesia. Follows an elaborate analysis of the secret societies of the island of Mota (Banks group). For reasons to be stated later the author ascribes these societies to an immigrant people, and detailed examination of the rituals of the societies provides a test for immigrant strata in Melanesian cultures. Supplementing this by a comparative study of methods of burial, the author finally resolves Melanesian culture into a series of strata: the most ancient culture of the dual people, followed by that of the kava people, followed by that of the betel

people. Last come certain recent influences from Micronesia and Polynesia. Polynesia, moreover, is made to participate in some of the other culture strata, so that a later Polynesian culture corresponds to an earlier Melanesian one, while the earlier Polynesian culture is given a share in the moulding of the culture of the dual people, which, therefore, also proves to be complex in character.

The remaining sections of the volume are devoted to an interpretation of the different aspects of Melanesian culture in the light of the cultural strata just outlined. Thus, linked totemism is regarded as due to two successive migrations of totemic peoples; conventionalized art is ascribed to the influence exerted by the geometrical art of one people on the realistic art of another; the origin of money is seen in the conditions which arise when two largely independent people live side by side; religion is a trait of the kava people, while the dual people were addicted to magic; sun and moon worship also come from the kava people, while stone work is due to ideas introduced by them; the bow and arrow belong to the kava as well as to the dual people, although they were subsequently lost among both; the plank-canoe was shared by the kava and betel peoples, while the dug-out originated with the dual people; the use of an inclusive and exclusive plural, finally, in some of the Melanesian languages points to the necessity of differentiating between two social strata.

In fairness to Dr. Rivers it must be said that the bare outline presented above does but poor justice to the author's amazingly complex argumentation. It will suffice, however, for the purpose of the present examination, which is not to refute the author—a task that would require a volume—but to characterize and expose his method. This restriction is the more justifiable as the author himself regards the "history" as a model of ethnological method.

In order to allow for a more deliberate analysis of the second part of Vol. II., the first part will be discussed very briefly. In it the author applies the method of survivals with little regard for probabilities. When a reconstruction based on a diagnostic utilization of relationship terms leads to the assumption of an ancient state of gerontocracy of a type hitherto unknown in concrete ethnographic experience, and of forms of marriage, such as that between individuals separated by two generations (a condition which, while it seems to occur, must certainly be regarded as highly exceptional), one pauses to think before accepting the author's conclusion. Again, although Dr. Rivers has certainly made good his contention that terms of relationship will reflect states of society, particularly of marriage—a position once held as a dogma by Lewis H. Morgan—and notwithstanding the new in part very striking evidence which the author's book brings in support of that contention, he clearly is guilty of deliberately overlooking the fact that social structure and function represent but two out of a set of factors which may and do influence relationship terms and systems. A set of terms must always remain a feature of language and as such it is subject to those influences which control linguistic changes as well as to the peculiar spirit of a particular language or linguistic stock. Again, a system of relationship, a set of terms, are phases of culture and, like other cultural features, they may spread from people to people, may be influenced by factors extraneous to the group to which they belong. While the theoretical validity of these propositions seems assured, one welcomes the fact that renewed interest in the numerous and intricate problems presented by the study of systems of relationship is manifested in a series of concrete and systematic investigations undertaken particularly by American anthropologists, investigations which have already brought valuable evidence in favor of a less one-sided attitude toward the problems of relationship systems and from which further results along similar lines may ere long be expected.[1]

But Dr. Rivers's principal error consists in

[1] *Cf.*, for instance, R. H. Lowie, "Exogamy and the Classificatory Systems of Relationship," *American Anthropologist*, Vol. 17, 1915.

the peculiar—one is tempted to say reckless—manner in which he applies the principle of the diffusion of culture in the second part of his theoretical argument. It is true, the author is not guilty of that mechanical handling of cultural features, like units of a physical mixture, which is so characteristic of Graebner's procedure. Dr. Rivers gives due weight to the psychological aspects of culture contact; he emphasizes, for instance, the observation that the very circumstances of the contact of two cultures may give rise to features foreign to both cultures before contact. He also devotes an entire chapter, perhaps the most valuable part of the volume, to an ordered consideration of the mechanisms and conditions, physical as well as psychical, of the diffusion of culture. But for all that the glaring unreality of the author's method remains the most striking feature of his book. Deliberately evading any attempt to furnish proof of diffusion in specific instances, the author erects a purely hypothetical structure, based on a bewildering maze of assumptions invariably favoring interpretations through diffusion while disregarding alternative interpretations. In the discussion of the secret societies of Mota, for instance, the author ascribes the secrecy of the societies, their multiplicity, as well as their grading in rank, to the fact that the societies were introduced by an immigrant people; they were secret because an open ritual in the presence of a hostile indigenous population (at another stage in the argument the population is assumed to be friendly to the newcomers) was dangerous; they were numerous because a constant stream of applicants for membership from the natives led to the formation of new societies; they were graded as to rank because a line had to be drawn between a society wholly of immigrant origin and one into which natives had already been admitted, and so on. Now, it is a well-known fact that religious societies such as those of Mota, whether they belong to other parts of Melanesia, to West Africa or to North America, are very commonly secret, multiple and ranked. No ground is found, in other places, to ascribe them to an immigrant people. Why, then, in Mota? The author is, indeed, aware of this circumstance. He admits the possibility of an alternative interpretation, but he rejects it in favor of his own, and proceeds with his argument (II., 213). Similarly, when discussing decorative art the author chooses to neglect the psychologically plausible and experientially verified tendency of designs to pass progressively from realistic forms to geometrical ones or of geometrical designs to become elaborated and often transformed through the addition of realistic appendages. For Dr. Rivers conventionalization is a factor "depending on the blending of peoples and of their cultures." By conventionalization he means "essentially a process by which a form of artistic expression introduced into a new home becomes modified through the influence of the conventions and long-established technique of the people among whom the new notions are introduced" (II., 383). The most striking instance of such procedure is perhaps the case of language, where the author ascribes the presence of the inclusive and exclusive plural to the necessity of differentiating between two classes of society. An inclusive and exclusive plural as well as dual occur, for instance, in quite a number of American Indian languages. In these instances Dr. Rivers himself would probably not find a sociological interpretation necessary. Why then so radical an assumption in the case of Melanesia, unless indeed it can be made something more than a mere assumption? An examination of several of the features used by the author as tests of his theory shows with great clearness how easy as well as futile it is to advance an interpretation of the facts through diffusion, unless proof can be furnished. We note a set of dual features: the sacred and the profane; higher and lower grades; chiefs and commoners; geometric and realistic designs; two communities with products to exchange; inclusive and exclusive plural; maternal and paternal descent; religion and magic. Now, it occurs at once that numerous instances could be cited where one or more of the

coupled traits coexist in the same community under conditions which preclude all possibility of ascribing one of the traits to an indigenous, the other to an immigrant culture. This being so, what justification is there for advancing such an interpretation in *any* case, unless the assumption can be supported by specific evidence? Obviously, the easier it is to explain a phenomenon in one of two ways, the more vigorous must be the proof if one of the two alternative explanations is selected.

After all, then, there is a close similarity between Rivers of the *Melanesian Society* and Graebner of *Die Melanesische Bogenkultur*. The former author takes special pains (II., 3, *seq.*) to assert his complete independence of Graebnerian method. That the author's position is in part justified, has been shown before. But in one respect the relationship of the two systems is unmistakable. Both authors utilize diffusion not as a process to be demonstrated but as one to be assumed for the purpose of hypothetical culture building. To be sure, what Rivers builds is altogether different from that which is built by Graebner, but the principles according to which the different parts of the structures are welded together are the same in either case.

Before closing it will be well to refer to Dr. Rivers's own definition of his method. We read:

> This method has been the formulation of a working hypothetical scheme to form a framework into which the facts are fitted, and the scheme is regarded as satisfactory only if the facts can thus be fitted so as to form a coherent whole, all parts of which are consistent with one another (II., 586).

The method, thus formulated, is, as a method of historical research, self-condemnatory. It may well be applied in the shaping of those hypothetical conceptual systems which are introduced by the theoreticians of the exact sciences for the purpose of providing a simplified description of the data of experience in a particular field. It does not matter how the vortex looks (or whether it looks at all), if only the functions of the ether can be readily derived from it. It may not be of importance whether the atom exists or not (with apologies to Lord Kelvin), but if it furthers a successful formulation of the facts of chemistry (a task in which of late it has conspicuously failed), its conceptual existence is vindicated. Not so in history. It has been said, with some truth, that for an understanding of society it is less important to know what has occurred than what may have occurred. But surely this does not apply to the study of history as such, nor to ethnology, in so far as its task is historical. Here the search is altogether for what has occurred, although the knowledge of what may have occurred can serve as a useful guide in the search. In the domain of ethnology, moreover, our knowledge of what has occurred will have to be increased many times before we can safely trust our intuitions as to what may have occurred.

To repeat, then, Dr. Rivers has labored fiercely against heavy odds, he has reopened an old and much trodden field; his work emphasizes once more the amazing cultural complexity of those southern seas; it is rich in subtle psychological analysis and happy formulation of theoretical principles; it also abounds in ingenious hypotheses of great *prima facie* plausibility. But we can not endorse this "history" as a model of ethnological method, for *a history* surely it is not.

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SPECIAL ARTICLES

LOBSTER MATING: A MEANS OF CONSERVING THE LOBSTER INDUSTRY

DURING the summer of 1914 the writer, working under the auspices of the Biological Board of Canada, attempted to rear lobster fry to the crawling stage, using the now familiar apparatus of the Rhode Island Commission. The site chosen for the repetition of the celebrated Wickford experiments was St. Mary's Bay, Digby Co., Nova Scotia. The attempt proved a complete failure due chiefly to the extreme cold water (50° F. to 60° F.) and to the extensive development of diatoms which soon closed up the mouth parts of the fry and caused an exceedingly high death rate.

However, an experiment that was at first supposed to be a very minor one compared with lobster rearing turned out to be the major one. It was this. About the middle of June, 47 females and 15 males (all known as "commercial lobsters," because the females when caught in fishermen's traps have no "berries" on them) were placed in a wooden pound enclosing an area of 10 feet by 20 feet. The slats of which the pound was built were about 4½ feet long, 3 inches wide and 1 inch thick. It was intended to retain the animals over winter for the purpose of elucidating the old question of whether or not adult females moult one year and extrude eggs the next, or whether they extrude eggs every year (when mating conditions are favorable) and only moult occasionally as they grow older.

On the 12th of August the whole of the 62 lobsters were dipped up to see what condition they were in. They all appeared healthy, and 36 per cent. of the females carried eggs. Dr. Herrick in his well-known book on the American lobster quotes from Vinal Edwards to the effect that the percentage of berried lobsters caught by fishermen off the Massachusetts coast was 12 per cent. for the autumn of 1893 to June 30, of 1894. Careful inquiries among both canners and fishermen of the St. Mary's area elicited the information that only about 1 per cent. of the females caught in fishermen's traps carried eggs. And then the question arose: How is it that in fishermen's traps only one female in every hundred carries eggs, whereas in our mating pen thirty-six out of every hundred carry eggs? The problem did not grow any simpler when it was found that by the end of September the percentage in our pen had risen to 64 per cent. The 17 females which did not extrude eggs were removed from the latticed pen and the 30 which bore eggs, representing the 64 per cent., were kept over winter in a compartment by themselves. On April 7, 1915, the 30 were all found to have the full complement of eggs upon them. Subsequently, in June and early July, they all hatched out their eggs, and being kept in compartments by themselves 9 of them were found to have extruded eggs in late July and August. These 9 were removed from the pen, the remaining 21 being retained, but unfortunately one corner of the enclosure gave way, allowing most of the 21 to escape and mingle with others, so that it was impossible to know how many more of them did extrude eggs.

Mating experiments were resumed during the summer of 1915, but were not so successful as those of 1914. Only 40 per cent. of the females extruded eggs, and the eggs were most of them unfertilized. Probably the sole reason for this was lack of males. During the early part of the summer we had only one male to mate with 51 females. Later on, we were fortunate enough to secure 25 more males, but half of these died from accidental poisoning by paint on the inside of our mating pens. Moreover, many of the remaining males were decidedly undersized—9½ to 10 inches in length. But perhaps the most fundamental reason for the poor showing of 1915 lay in the fact that the large majority of the females had been retained in the pound over winter, and as a consequence had suffered considerably in general health. Few of them had moulted and their "shells" were covered with dark brown algal growths that I have always seen upon lobsters when in lengthened confinement, but never upon those which were taken directly from the open sea.

In 1916 the Biological Board authorized an extension of the mating experiments to two other places on the maritime coast, namely, St. Andrew's, New Brunswick, and Pictou, on Northumberland Straits. The results to date are 25 "berried" out of 105 in St. Mary's Bay, 8 out of 22 at St. Andrews and 14 out of 21 at Pictou, or, expressed in percentages, 25 per cent., 36 per cent. and 66 per cent., respectively.

How do these percentages compare with the percentages of females caught in lobster traps in these same areas? Fortunately, through the courtesy of the Department of Naval Service, Ottawa, we were able to make a close approximation to an answer to this question. At the request of the Biological Board, the naturalist of the Fisheries Branch, Mr. Andrew

Halkett, was detailed to spend the summer in going out with lobster fishermen all around the coast, and in collecting statistics as to the total males, total females and percentages of berried females caught in lobster traps. The following is a copy of his summary of results:

Date	Name of Place	No. Males	No. Females	No. Females which Carried Eggs	Remarks by Dr. Knight
April 24, 1916	Tommy's Beach, N.S.	56	58	0	
April 25, 1916	Tommy's Beach, N.S.	26	27	0	
April 28, 1916	Little River, N.S.	23	17	0	
May 2, 1916	Whale Cove, N.S.	25	28	0	
May 3, 1916	White Cove, N.S.	26	19	1	Egg of 1915
May 5, 1916	Tiverton, N.S.	9	20	0	
May 15, 1916	Lunenburg, N.S.	36	35	1	Egg of 1915
May 17, 1916	Port Mouton, N.S.	50	39	3	Eggs of 1915
May 20, 1916	Shag Harbor, N.S.	46	54	0	
May 22, 1916	Shag Harbor, N.S.	88	112	0	
May 23, 1916	Shag Harbor, N.S.	39	70	2	Eggs of 1915
May 24, 1916	Shag Harbor, N.S.	171	158	0	
May 26, 1916	Cape Sable Island, N.S.	68	98	0	
May 30, 1916	Lobster Bay, West Pubnico	82	73	0	
June 2, 1916	Cape St. Mary's, West Pubnico	66	86	0	
June 6, 1916	Mink Cove, N.S.	34	25	1	Egg of 1915
June 10, 1916	Little River, N.S.	24	28	0	
June 12, 1916	Little River, N.S.	14	10	0	
June 15, 1916	Ostrea Lake, N.S.	16	14	0	
June 16, 1916	Jeddore, N.S.	169	191	6	Saw first eggs hatching 1915
June 20, 1916	Pope's Harbour, N.S.	6	6	0	
June 24, 1916	Pugwash, N.S.	366	352	50	9/10 old, 1/10 new eggs
June 28, 1916	Skinner's Reef, N.S.	56	36	1	Egg of 1915
June 29, 1916	Pictou Island, N.S.	24	39	1	New eggs (1916)
July 10, 1916	Northport, N.S.	111	110	10	9 old eggs, 1 new
July 13, 1916	Shemogue, N.B.	108	95	3	1 egg 1915, 2 new
July 17, 1916	Dupin's Corner, N.B.	50	27	1	Egg 1916
July 19, 1916	Cormierville, N.B.	133	105	0	
July 20, 1916	Chockfish River, N.B.	139	119	1	Eggs new
Aug. 1, 1916	Cape Traverse, P.E.I.	157	158	1	Eggs new
Aug. 2, 1916	Cape Traverse, P.E.I.	134	112	2	Last eggs seen hatching
Aug. 4, 1916	Brae Harbour, P.E.I.	164	108	1	New eggs (1916)
Aug. 5, 1916	Rocky Point, P.E.I.	135	77	1	New eggs (1916)
Aug. 7, 1916	Brae Harbour, P.E.I.	207	118	3	New eggs (1916)
Aug. 9, 1916	West Point, P.E.I.	325	274	5	New eggs (1916)
Aug. 10, 1916	Brae Harbour, P.E.I.	150	100	3	New eggs (1916)
	Totals....................	3,333	3,004	97 or 3.2%	

Samples of all eggs were sent to me for the determination of the age of the eggs.

Let us compare these results with statistics furnished me by Dr. Hugh M. Smith, the fish commissioner at Washington, as to the number of lobsters taken off the Massachusetts coast.

Dr. Smith is careful to state that the number of berried females is probably understated, because of the carelessness of fishermen in making returns. We are quite certain that the percentages for 1894–95 are too low, because we have Vinal Edwards's catch off Woods Hole already referred to for these same years, showing 12 per cent. of the females as carrying eggs. Does this mean that 88 per cent. of the female lobsters off the Massachusetts coast are sterile? If female lobsters moult every second year and extrude eggs in the alternate years, why do not 50 per cent. of them carry eggs? But they do not, as every fisherman knows.

The fact is that the biennial theory of moulting and spawning can not be held any longer. In the sixties and seventies when about half the females carried eggs (see Vinal Edwards quoted by Herrick in regard to 63.7 per cent. of the females off No Man's Land being ber-

ried) the theory seemed to fit the facts. To-day it does not.

Year	No. Lobsters Above 10½ Inches	Egg-bearing Lobsters	Estimated Females—about Half the Total	Percentages of Berried Females
1888	1,740,850	....	....	
1889	1,359,645	61,832	679,823[1]	9 per cent. berried
1890	1,612,129	70,909	806,065	
1891	1,292,791	49,973	646,395	
1892	1,107,764	37,230	553,887	
1893	1,149,732	32,741	579,866	
1894	1,096,834	34,897	548,467	6 per cent. nearly
1895	956,365	34,343	478,187	7 per cent. nearly
1896	995,396	30,470	497,698	6 per cent. nearly
1897	896,273	23,719	498,186	
1898	720,413	19,931	360,206	
1899	644,633	16,470	322,316	
1900	646,499	15,638	323,299	
1901	578,383	16,353	289,190	5 per cent.
1902	670,245	....	335,127	
1903	665,466	....	332,733	
1904	552,290	13,950	276,145	
1905	426,471	9,865	213,235	4.6 per cent.
1907[2]	1,039,886	10,348	519,943	2 per cent.
1908[2]	1,035,123	9,081	517,561	
1909[2]	1,326,219	11,656	663,109	
1910[2]	935,356	7,857	467,678	1.6 per cent.

The question to be answered is this: How is it that off the Massachusetts coast in 1910, only about 2 per cent. of the females carried eggs? Even if the figures are not absolutely correct, the general falling off in percentage since 1888 is most marked. In Canada, we have collected no statistics until this year (1916), and Mr. Halkett's returns show that an average of about 97 per cent. carry no eggs. Are these females all sterile? Impossible belief!

For the Canadian coast, therefore, it is clear, that the percentage of females which carry eggs in traps varies from less than 1 per cent. in the Bay of Fundy area (which may be said to include St. Mary's and St. Andrew's) to about 4.2 per cent. in Northumberland Straits; whereas, by mating experiments in these same areas the percentages are increased by an average of 3,000 per cent. in the former and 1,600 per cent. in the latter area.

[1] The estimate of females, as half of the totals is mine.—A. P. K.

[2] Number of lobsters above 9 inches.

Early in our experiments this summer the possibility occurred to me that females in the open sea might in autumn carry more eggs than they do in spring and early summer. In other words, many females might for one reason or another lose their eggs during the winter, and thus reduce the percentage to that elucidated by Mr. Halkett. This possibility was tested to some extent during August and September (1916). Through the courtesy of the Minister of Fisheries, the Hon. J. D. Hazen, I was permitted to fish for lobsters from August 19 to August 31, and found the percentage to 2½ per cent. for the Pictou area. Fishing was again resumed during the last four days of September, when the percentage was found to have increased to 5.6 per cent. Moreover, during September we had 25 males and 25 females confined in the mating pen, and although the enclosure gave way at one corner and allowed some of the lobsters to escape, nevertheless 13½ per cent. of the females were found to have extruded eggs. Here the increase by mating is quite clear.

While I dislike theorizing at this stage in the experiments, I may be permitted to suggest that probably the majority of female lobsters extrude their eggs every year; but that as the total males and females are now greatly reduced through overfishing, and relatively widely separated from each other in the open sea, there is less copulation than formerly, with consequent lack of fertilization of eggs. Being unfertilized the eggs soon "go bad," and drop off. On the other hand, mating brings the sexes together with a resulting increase in the numbers of females carrying fertilized eggs.

We may safely conclude, therefore, that the efficacy of mating as a means of increasing the number of berried females is fairly well established, on the supposition, of course, that the catch of berried females fairly represents the number of berried females in the bottom of the sea. At any rate, the results amply justify further experiments on a large scale, and if further results prove as successful as those of the past three years, they far surpass the results of either lobster hatching or lobster

rearing as a means of conserving the lobster industry.

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THE ROYAL SOCIETY OF CANADA

The thirty-fifth meeting of the Royal Society of Canada was held, this year, in the Chateau Laurier at Ottawa, Province of Ontario, under the presidency of Professor Alfred Baker, M.A., LL.D., of Toronto University. There was a large attendance of fellows from all the provinces of the Dominion. As is well known to readers of Science, this society is essentially national in character; and in the four sections into which the society is divided, the archeological, literary, historical as well as scientific leaders in thought, of English as well as of French Canada, are represented. The society meets but once a year in conclave, but sections can be called at the bidding of its officers to carry out programs of lectures, reading of papers or similar functions with a view of furthering the aims of the society.

Seventeen affiliated societies of Canada reported through their official representatives or delegates. The war now raging in Europe has affected the society to a marked degree, not only in the attendance at the annual meeting owing to the number of fellows serving at the front, but also in the distribution of the publications. There was no distribution to enemy countries.

Death has removed several fellows, including Sir Sandford Fleming; Dr. W. F. King, astronomer; Dr. Samuel E. Dawson, littérateur, historian and geographer, and Monsieur Ernest Gagnon, historian.

The third and fourth sections of the Royal Society of Canada are those specially devoted to the sciences, and papers were presented and read which cover the wide field of research common to all nationalities and special interest to readers of Science.

List of Papers presented in Section III, Chemical and Physical Sciences

Presidential address. By Dr. F. T. Shutt, M.A., F.I.C.—"Agricultural Research in Canada."

"The Turn of Tidal Streams in relation to the Time of the Tide," by W. Bell Dawson, M.A., D.Sc., M.Inst., C.E., F.R.S.C.

"The Smelting of Titaniferous Iron Ores," by Alfred Stansfield, F.R.S.C., D.Sc., A.R.S.M., professor of metallurgy, McGill University, and William Arthur Wissler, M.Sc., of McGill University.

"Factors connecting the Concentration and the Optical Rotatory Power of Aqueous Solutions of Nicotine," by Alfred Tingle and Allan A. Ferguson. Presented by Professor W. R. Lang, F.R.S.C.

"A New Method for the Determination of Nicotine in Tobacco," by Alfred Tingle and Allan A. Ferguson. Presented by Professor W. R. Lang, F.R.S.C.

"The Influence of Fertilizers on the Flow of Water through Soils," by C. J. Lynde, Ph.D., professor of physics, and R. Dougall, B.S.A., research assistant under the Dominion Grant for Agriculture, Macdonald College, P. Q. Presented by Dr. H. T. Barnes, F.R.S.

"On the Initial Charged Condition of the Active Deposits of Radium, Thorium and Actinium," by G. H. Henderson, B.A., B.Sc., instructor in physics, Dalhousie University. Presented by H. L. Bronson, F.R.S.C.

"The Structure of Hailstones of Exceptional Form and Size," by Francis E. Lloyd. Presented by Professor C. H. McLeod, F.R.S.C.

"Human Adipocere," by R. F. Ruttan, M.D., F.R.S.C.

"Formation of Ring Ice or Hoar Frost in Pipes," by Professor H. T. Barnes, F.R.S.C.

"Contact Resistance in Oil," by H. E. Rielley, M.Sc., and Violet Henry, M.Sc. Presented by Professor H. T. Barnes, F.R.S.C.

"The Contact Resistance between Conductors in Relative Motion," by Violet Henry, M.Sc. Presented by Professor H. T. Barnes, F.R.S.C.

"The Solubility of Aluminium Hydroxide in Solutions of Ammonia," by E. H. Archibald and T. Habasian. Presented by Professor Ruttan.

"The Occlusion of Iron by the Ammonium Phosphomolybdate Precipitate," by E. H. Archibald and H. B. Keegan. Presented by Professor Ruttan.

"A Comparison of Radium Standard Solutions," by J. Moran. Presented by Professor A. S. Eve, F.R.S.C.

"The Release of Radium Emanation from Water at Different Temperatures by Bubbling Air through the Solution at a Uniform Rate," by J. Moran. Presented by Professor A. S. Eve, F.R.S.C.

"The Double Salts Formed by Sodium and Potassium Carbonates," by J. W. Bain, F.R.S.C., and C. E. Oliver.

"On the Effect of Stationary Sound Waves on Viscous Flow in Pipes and Channels," by Louis Vessot King, M.A. (Cantab.), D.Sc. (McGill), F.R.S.C., associate professor of physics, McGill University, Montreal.

"Concerning a Certain Non-involutory System of Partial Differential Equations," by C. T. Sullivan, lecturer in mathematics, McGill University, Montreal. Presented by Jas. Harkness, F.R.S.C.

"The Algebraic Basis for Two Formulæ in the Theory of Expansions according to Bessel Functions," by James Harkness, M.A., F.R.S.C.

"Alternate Number Indices in Triangular Coordinates," by J. C. Glashan, LL.D., F.R.S.C.

"On the Scattering and Attenuation of Radiation in the Solar Atmosphere," by Louis Vessot King, M.A. (Cantab.), D.Sc. (McGill), F.R.S.C., associate professor of physics, McGill University, Montreal.

"On Boundary Conditions in the Dynamical Theory of Gases," by Louis Vessot King, M.A. (Cantab.), D.Sc. (McGill), F.R.S.C.

"Progress on 72-inch Reflecting Telescope," by Dr. J. S. Plaskett, F.R.S.C., Dominion Observatory, Ottawa.

"Hygrometry," by A. Norman Shaw, B.A. (Cantab.), D.Sc., Macdonald College, McGill University. Presented by Professor H. T. Barnes, F.R.S., F.R.S.C.

The important question of industrial research introduced by the president, was very thoroughly discussed at two sessions of the Section and various opinions as to the best methods of procedure were advanced. The following resolution which was adopted represents the final conclusion arrived at by the members of Section III.:

"WHEREAS, it is important that the scientific forces of Canada should be organized to aid in the vigorous and efficient prosecution of the war and in the development of Canadian industries to meet the present conditions as well as those which may prevail after the war,

"*Resolved* that the Royal Society of Canada respectfully suggests to the government the appointment of a committee or commission of scientific men whose duty it shall be to advise the government how best to utilize the men and laboratories available for such purposes."

The commemoration of the 50th Anniversary of Confederation was decided to be marked, at the meeting of 1917, by historical papers dealing with the progress of the various divisions of mathematical and physical sciences. The officers of the Section were asked to select the members who would prepare such papers.

The election of officers for Section III. resulted in the choice of the following:

President—R. F. Ruttan, M.D., C.M., D.Sc.

Vice-president—A. S. Eve, D.Sc.

Secretary—F. T. Shutt, M.A., D.Sc.

Progress was reported on the 72-inch reflecting telescope now approaching the final stages of erection and adjusting at the Dominion Observatory at Ottawa, Canada.

SECTION IV. (GEOLOGICAL AND BIOLOGICAL SCIENCES)

This section reports five sessions under the chairmanship of Mr. J. B. Tyrrell, M.A., F.G.S.

Twenty-nine fellows were in attendance as follows: Messrs. Adams, Bailey, Bethune, Brodie, Buller, Coleman, Dowling, Dresser, Faribault, Faull, Grant, Harrison, Hewitt, Huard, Lambe, Macallum, Mackay, McConnell, McInnes, McMurrich, Matthew, Moore, Parks, Prince, Tyrrell, White, Harris, Hunter and Lloyd. Four absent Fellows are on active service: Dr. Adami, Dr. Harrison, Dr. MacKenzie and Dr. Nicholls.

To the membership were added the names of Professors Harris, Hunter, Lloyd and Fraser.

The following officers were chosen for the year 1916–17:

President—J. P. McMurrich, F.R.S.C.

Vice-president—R. G. McConnell, F.G.S.

Secretary—J. J. Mackenzie, F.R.S.C.

Acting-Secretary—J. H. Faull, F.R.S.C.

Publication Committee—Dr. Hewitt, Mr. Dowling and Dr. Harrison.

List of Papers Presented in Section IV

Twenty-one papers, a list of which is appended, including a presidential address of much interest on "Notes on the Geology of the Nelson and Hayes River, Manitoba," were presented to the Section, contributions in the gross that represented a large amount of important and stimulating work.

Presidential Address—"Notes on the Geology of the Nelson and Hayes River, Manitoba," by J. B. Tyrrell, F.R.S.C.

"Notes on the Plankton of the British Columbia Coast," by J. Playfair McMurrich, F.R.S.C.

"On a New Anthomedusan from the Coast of British Columbia," by H. B. Bigelow. Presented by Professor McMurrich, F.R.S.C.

"The Quantitative Study of Climatic Factors in Relation to Plant Life," by J. Adams, M.A. Presented by C. Gordon Hewitt, D.Sc., F.R.S.C.

"Geologic Range of the Phyla, Classes, Subclasses and Orders of the Plant and Animal Kingdoms," by Lancaster D. Burling. Geological Survey, Canada. Presented by Lawrence M. Lambe, F.R.S.C.

"Ganoid Fishes from near Banff," by Lawrence M. Lambe, F.R.S.C., F.G.S.A., vertebrate paleontologist to the Geological Survey, Canada.

"Achondroplasia, a Problem in Development," by Albert G. Nicholls, M.A., M.D., Sc.D.

"Studies on a Timber Destroying Fungus—*Fomes officinalis*," by J. H. Faull, Ph.D., F.R.S.C.

"Notes on Cambrian Faunas," by G. F. Matthew, LL.D., D.Sc.

"Studies on the Protozoan Parasites of the Fishes of the Georgian Bay," by J. W. Mavor, B.A., Ph.D., University of Wisconsin, Madison, U. S. A. Presented by E. E. Prince, LL.D., F.R.S.C.

"Statistical Studies on the Growth of the Pollock, Haddock and Hake," by J. W. Mavor, Douglas Macallum and Dorothy Duff; with twenty figures. Presented by E. E. Prince, LL.D., F.R.S.C.

"The Abscission of Flower-buds and Fruits in its Relation to Environmental Changes," by Professor Francis E. Lloyd, F.R.S.C.

"On the Development of *Æquorea forskalea*," by C. McLean Fraser, Ph.D., F.R.S.C.

"Bibliography of Canadian Botany for the Year 1915," by A. H. MacKay, LL.D., F.R.S.C.

"Bibliography of Canadian Entomology for the Year 1915," by C. J. S. Bethune, D.C.L., F.R.S.C.

"Bibliography of Canadian Zoology for 1915 (exclusive of Entomology)," by E. M. Walker, B.A., M.B., F.R.S.C.

"Bibliography of Canadian Geology for the Year 1915," by Wyatt Malcolm. Presented by R. G. McConnell, B.A., F.R.S.C.

"Some Further Observations on the Discharge of Spores in the *Uredineæ*," by Professor A. H. Reginald Buller, F.R.S.C.

"Upon the Germination of the Spores of *Coprinus Sterquilinus*," by Professor A. H. Reginald Buller and S. G. Churchward.

"Structure of the Basin of Lake St. John," by J. A. Dresser, F.R.S.C.

"Dysentery, and the Dysentery Bacillus. A Report of some Cases with Isolation of Organisms of the Shiga Group," by R. F. Kelso, M.D., and W. Sadler, B.S.A.

GENERAL NOTES

The council of the society recommended to the various sections the advisability of suitably commemorating the 50th anniversary of confederation of the various provinces of British North America by preparing papers dealing with the progress of literature and science in Canada during this period. Action on the part of the sections followed.

The presidential address by Professor Baker, of Toronto University, was entitled "Canada's Intellectual Status and Intellectual Needs."

In this address the retiring president, Dr. Baker, discussed the educational problems of the various provinces of all Canada, of native born and also those of European birth. The writer argued for an increased study of the French language, and then turned his attention to the press, the public libraries and to technical education as well as education in agriculture for the Dominion.

Museums, as factors in modern civilization, were also discussed, including art museums. Canadian literature, agricultural research, the work of the Biological Board of Canada, and general scientific research, on the lines of the Carnegie Institute, followed together with the work of the Rockefeller Institute and similar institutions in the United States that make for the benefit of humanity as a whole. Professor Baker paid a glowing tribute to the benefactors in the United States who by endowments and munificent donations, had done so much to increase our knowledge in so many directions, thus raising the status of research work to such a pitch that the summit or center of gravity of scientific discovery in this world may soon be found in the Republic of our neighbors.

The officers for 1916–17 are as follows:

Hon. President—His Grace the Duke of Devonshire, Governor-General of Canada, etc.

President—Professor A. B. Macallum (Toronto, Ont.).

Vice-president—His Honor Mr. Justice J. W. Longley.

Hon. Secretary—Mr. Duncan C. Scott (Ottawa, Ont.).

Hon. Treasurer—Dr. C. Gordon Hewitt.

Hon. Librarian—Mr. D. B. Dowling.

Amongst the other papers read before Section II., not included in the foregoing, of special interest in geography, archeology, ethnology, etc., may be mentioned the following:

1. "Place Names in the Southern Rockies," by James White, F.R.G.S., Canadian Commission of Conservation (Ottawa).
2. "Signposts of Pre-historic Time," by W. D. Lighthall, M.A. (Montreal).
3. "An Organization of the Scientific Investigation of the Indian Place-Nomenclature of the Maritime provinces of Canada" (sixth paper), by Professor W. F. Ganong, M.A., Ph.D.
4. "The Refugee Loyalists of Connecticut," by Professor W. H. Siebert, of the Ohio State University.

H. M. Ami

Geological Survey,
Ottawa, Canada

SCIENCE

FRIDAY, DECEMBER 15, 1916

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

THE RELATION OF MATHEMATICS TO THE NATURAL SCIENCES[1]

IN considering the relationship of mathematics to the natural sciences, we shall do well to see what mathematics is and what are its methods.

Mathematics has not always been looked at through the same glasses. The field of mathematics to the early workers was number and quantity. Euclid put into his axioms what he considered to be the fundamental facts of the world about him. Diophantus, of Alexandria, a worker in algebra, considered only positive roots of equations. They were dealing with realities and not with abstract matters. Some time later mathematicians tried to prove their axioms—often called self-evident truths—and made a wonderful discovery. That was, that a "self-evident truth" might be replaced by its contrary and the result still be a consistent body of doctrine. And thus the glasses were changed, to be mathematical the conclusions must be the result of the assumptions and these must be consistent. The assumptions need have no physical interpretation, indeed they might contradict any of our theories, but they must not contradict each other. There might be foreign war, but no internal conflict. I like the following of Professor Keyser, of Columbia University:[2]

> He (the mathematician) is not absolutely certain, but he believes profoundly that it is possible to find axioms, sets of a few propositions each, such that the propositions of each set are compatible, that the propositions of such a set imply other propositions, and that the latter can

[1] Read before the Purdue University chapter of Sigma Xi, October 25, 1916.

[2] SCIENCE, Vol. 35 (1912), p. 107.

be deduced from the former with certainty. That is to say, he believes that there are systems of coherent or consistent propositions, and he regards it as his business to discover such systems. Any such system is a branch of mathematics.

A word might be said about pure and applied mathematics. We may have a branch of mathematics with its postulates or axioms consistent and have no physical interpretation of them. On the other hand, we may make our postulates consistent with what we believe to be the proper interpretation of certain phenomena, and this would be applied mathematics. It is to be observed that after we have our conditions once fixed by our interpretation of these phenomena, we proceed to our conclusions in a way which is wholly independent of whether we have the right interpretation or not, and are thus back in the domain of pure mathematics.

The popular conception of mathematics has been that it devoted itself to problem solving. You will see, however, that the mathematician concerns himself not with the solution of particular problems, but with the principles which underlie the solution of classes of problems. There is and has been a lively interest in problem solving as is evidenced by the problem departments of various journals. To some the solution of these problems has offered simply the diversion which comes from the solution of a puzzle, to others they have offered a real mathematical stimulus.

There are two general methods of working—I mean of research—in mathematics, the intuitional and postulational. In the case of the first the worker jumps to his conclusions, as it were, guided by some analogy or by his sense of what the facts should be or by his experience; and then follows this drawing of conclusions by filling in his proof by rigorous deduction. In the second method the postulates are kept definitely in view and results are reached by deduction. Most discoveries are, I think, made by the intuitional method. Most progress can be made by leaping across barriers and viewing the country beyond and then returning to build roads and tunnels. It is true that when we attempt to build the road it may not lead us where we leaped, it may not lead us anywhere, and we must return to our starting point. But we build with so much more enthusiasm, with so much more skill, if we think we know where the road leads. The postulational method of work is more formal and is a better tool for the road building than for spying out the land.

We learned our arithmetic by the intuitional method. We said $1 + 1 = 2$, not because of some set of postulates, but because in our experience one and one gave something to which we attached the name two. Now to set down our postulates and prove that $1 + 1 = 2$ is possible and profitable at the proper time, but altogether out of place in an elementary arithmetic. In plane geometry we had our introduction to the postulational method. In this subject we started with a set of postulates explicitly stated and deduced from them certain results. In discovering the facts of Euclidean geometry, intuition is largely called upon, while in setting those facts down in a text-book we use the postulational method. Euclidean geometry is so largely intuitional in discovery because its postulates agree with our notions of space. In the non-Euclidean geometries we can not trust our intuition and must depend directly on our postulates.

If instead of saying that the whole is equal to the sum of its parts, we say that a part may equal the whole, our intuition is no safe guide. Other examples might be given.

Research work in mathematics attracts two classes of workers, those interested for

mathematics' sake and those interested in creating a tool with which to attack some other science. The search after truth—geographical, religious, scientific—has always lured men. The desire to create, to build some new thing, is continually finding outlet in invention, in exploration, and in scientific research. That desire which sends some men to the poles of the earth, to the tops of mountains, or to the heart of the desert, sends other men over the mountain tops of geometry, or among the pitfalls of analysis, or through the labyrinth of point sets, to some hitherto untrodden field of mathematics. The mathematician creates an intellectual fabric which is just as real and just as beautiful to him as the tapestry is to the weaver. Some put forth their effort in any field that attracts; others, the utilitarians, choose parts which they think will be fruitful in applications.

Knowledge of pure science precedes its application. The properties of conic sections were well known before Kepler and Newton wanted to use them in their theories of planetary motion. The infinitesimal calculus was developed before and not after it was needed in physics. The differential equation had to be understood before it could be applied. Mathematicians have ready now the integral equation and the difference equation which, I believe, have only made a beginning in their service to science. It may be the man who is not seeking utilitarian ends who discovers the most useful facts. Roentgen was not seeking an aid for the medical profession when he discovered the X-rays. That man who reads carefully the history of scientific discovery and its application will not criticize any worker for choosing a field which is apparently remote from usefulness.

How many are working in mathematics, what have they done and what are they doing? There are some six or eight of the more important mathematical societies in various parts of the world with a total membership of over three thousand. These societies comprise in their membership practically all the research workers, besides many others not so engaged. The Subject Index of the Royal Society of London Catalogue of Scientific Papers, volume 1, which gives practically a complete list of mathematical articles which appeared during the nineteenth century, says in its preface that it contains 38,748 entries referring to articles in 701 serials and has rejected 750 as having no scientific value. G. Valentin, of Berlin, has collected a list of 150,000 titles of books and articles published before the beginning of the twentieth century. The *Jahrbuch über die Fortschritte der Mathematik* is a yearly review and each year publishes a volume of about 1,000 pages with very short reviews of books and of papers published in about 200 serials. A very conservative estimate would be that each year there appear 2,000 articles, in addition to the books which contain no new matter. Professor G. A. Miller, of Illinois University, estimates that there was published during the first fifteen years of the present century about one fifth as much mathematical research as during all time before. Mathematicians have varied greatly in their productivity. At one extremity is Galois, killed in a duel before he was twenty-one years old, whose essential contribution to mathematics requires about sixty pages of print; and at the other are Cauchy, whose works are expected to fill twenty-seven volumes when printed, and Euler, the printing of whose work as planned will fill forty-five large volumes.

Now, what relation can this science which deals with the abstract have to do with the natural sciences which deal with

the concrete? Professor A. Voss, of the University of Munich, said in a lecture in 1908:

> Our entire present civilization, as far as it depends upon the intellectual penetration and utilization of nature, has its real foundation in the mathematical sciences.

You will observe that he does not say in mathematics, but in the sciences which have made use of mathematics in their development. Let us investigate this a little. Can you realize what would happen, just what stage of civilization we should be in, if all that is developed by the use of mathematics could be removed from the world by some magic gesture? Every branch of physics makes use of mathematics; chemistry is not free from it; engineering is based upon its developments; sociology, economics and variation in biology make use of statistics and probability. Our skyscrapers must disappear; our great bridges and tunnels must be removed; our transportation systems, our banking systems, our whole civilization, indeed, must step backward many centuries.

Mathematics and its symbolism appear in rather unexpected places. S. G. Barton,[3] of the Flower Observatory, University of Pennsylvania, says that in the Encyclopædia Britannica, written not for the specialist so much as for the general reader, there are one hundred four articles which make use of the notation of the infinitesimal calculus, of which only about one fourth are pure mathematics. You may be surprised to know that you need the infinitesimal calculus to read the articles on clock, heat, lubrication, map, power transmission, ship building, sky, steam engine and strength of materials.

Take these sentences from Simon Newcomb's article in the Encyclopædia Britannica on celestial mechanics:

> The purpose of the present article is to convey a general idea of the methods by which the results of celestial mechanics are reached, without entering into those technical details which can be followed only by a trained mathematician. It must be admitted that any intelligent comprehension of the subject requires at least a grasp of the fundamental conceptions of analytical geometry and the infinitesimal calculus, such as only one with some training in these subjects can be expected to have. . . . The non-mathematical reader may possibly be able to gain some general idea, though vague, of the significance of the subject.

Sir John Herschel in his introduction to his book, "Outlines of Astronomy," says:

> Admission to its (astronomy's) sanctuary and to the privileges and feelings of a votary is only to be gained by one means—sound and sufficient knowledge of mathematics, the great instrument of all exact inquiry, without which no man can ever make such advances in this or any other of the higher departments of science as can entitle him to form an independent opinion on any subject of discussion within their range.

Professor and Mrs. Mittag-Leffler have given their fortune to the founding of an institute for the promotion of research in pure mathematics in Sweden and the other Scandinavian countries. They say:[4]

> Our testament owes its origin to the lively conviction that a people that does not accord to mathematics a high place in its estimation, will never be in a position to fulfil the most lofty tasks of civilization, and to enjoy in consequence that international consideration which is itself, in the end, an effective means of preserving our place in the world and of safeguarding our right to live our own life.

I am not claiming any superiority for mathematics over the other sciences. I am trying to emphasize how indispensable mathematics has been in the development of other sciences. Wherein lies its worth?

Mathematics is an exact science, that is, with the conditions—the postulates—definitely given, the conclusion admits of no doubt, of no variation. The worker in the

[3] SCIENCE, Vol. 40 (1914), p. 697.

[4] *Bulletin of the American Mathematical Society*, Vol. XXIII., No. 1 (1916), p. 31.

fields of the natural sciences sees the result—the conclusion—before him and tries to work back to underlying causes. Nature has laid a foundation and reared thereon a mighty superstructure, through which the natural scientist wanders amid a maze of halls and chambers, scratching the surface a little here and a little there trying to find what sort of a foundation can support all this that he sees. The natural scientist accepts as his foundation that theory which best explains the results. The theory may be wrong, but it serves all the purposes of a scientific theory if it explains to a fair degree of satisfaction observed phenomena. I seem to remember to have read the statement of a physicist that we should probably explain some phenomena of light on the wave theory and other phenomena on the atomic theory. Whenever a theory is contradicted by experiments, the natural scientist seeks another. This may seem a rather "hit or miss" way of scientific research, but it is the best that man can hope for with his human intellect trying to find first causes underlying the workings of a universe.

The mathematician is not thus restricted. He lays his own foundation. Some natural science may furnish the material for this foundation, but the mathematical mason handles each stone and sets it in proper relationship in the mortar of consistency.

By being an exact science, mathematics serves the natural sciences in two ways. In the first place, the methods of mathematical deduction offer a convenient means of testing the consistency of a theory. Mathematics will take the essential elements of a theory as postulates and deduce the necessary conclusions. If this leads to a contradiction of experiment, the incorrectness of the theory is shown. It might even be possible in certain cases to locate exactly what part of the theory is at fault. If the deduced results agree with experiment our faith in our theory is strengthened. An example of this sort of thing is to be found in Carmichael's "Theory of Relativity." The author, a mathematician, has taken as his postulates statements whose truth is accepted by a number of physicists. He has arrived, by purely mathematical means, at results whose truth or falsity are susceptible of experimental proof. The results of such an experiment as he suggests would disprove or increase our faith in the truth of his postulates.

A second way in which this exact science can serve the natural sciences, and which does not differ much from the way already mentioned, is in the matter of discovery. If the postulates of a natural theory are true, then all its consequences are true. Mathematics offers a tool for finding out these consequences. A classic example of discovery in this manner is Maxwell's prediction of the pressure due to heat or light radiation, which was not experimentally demonstrated for several years after Maxwell's death. Sir W. R. Hamilton's prediction of conical refraction is another such example. This prediction was experimentally verified by his colleague Lloyd within a short time after it was announced. This mathematical working out of the consequences of a theory has, in my judgment, not received its due at the hands of the natural scientist.

A more universal service rendered by mathematics has been the furnishing of a system of shorthand that is as exact and much more workable than the completely written out statement. If you do not believe in the value of a well-chosen symbolism, try to calculate the value of 22⅓ dozen eggs at 39½ cents per dozen by using Roman notation. A well-known example of the value of symbolism is furnished by mathematics itself in the development of the

calculus. Newton and Leibnitz made independent discoveries in this field. Newton chose a rather clumsy notation, Leibnitz our present notation. The English mathematicians used the Newtonian notation and were hampered to such an extent that they fell far behind the continental mathematicians in the development of the calculus. The graph is an example of an almost universal scientific symbol for representing tabulated data. Some one has said that we capitalize our knowledge in an equation. The natural scientist finds a well-developed symbolism in mathematics and proceeds to make use of it without taking the trouble of creating one of his own.

I have spoken of the service of mathematics to the natural sciences. There is a return service. The natural sciences furnish a rich field for mathematical research. One of the problems that has called forth the efforts of many mathematicians in the recent past has been the three body problem. There are many others of lesser note and many more still untouched. In a number of the *Bulletin of the American Mathematical Society* for 1914, there appeared a letter from a Mr. Paaswell, an engineer, enumerating a number of engineering problems which he thinks the mathematician should attack. Physics and mathematics have acted and reacted upon each other to the enrichment of both. Witness the work of J. C. Maxwell.

The natural sciences and developments based upon them not only furnish a rich field for mathematical research, but a field which promises to quickly make mathematics of service to the world. The scientist in any field feels justified in his labors if he discovers new facts, whether or not they are immediately applicable to the problems of daily life. He hopes they will be serviceable some day. The investigator in pure mathematics may work for the pleasure he gets from his mental creations, but in most men there is the deeper purpose of serving the world. The natural sciences furnish a field for the choice of postulates, the development of the consequences of which gives prospect of practical worth in the immediate future.

The mathematician is always confronted by the question of the consistency of his postulates. If these are chosen from some natural science, he can often find some physical system in which his postulates are verified. This exhibition of an example in which the postulates are verified and which from the fact of its physical existence offers no contradictory conclusions, is the best proof of consistency.

In our colleges and technical schools the time the engineering student or student of pure science gives to mathematics is reduced to a minimum in order to make room for more technical subjects, and in our graduate schools the mathematical student is given little opportunity to study anything but pure mathematics. The result is that one group of students knows too little mathematics to develop properly their field of study and the other group knows too little of the natural sciences and their application to apply to them their knowledge of mathematics.

How can we remedy this? I do not know. Not every engineering student or student of pure science should be required to become proficient in mathematics, nor every mathematician be required to become an engineer. This would be a great waste of time and effort without commensurate returns. The sooner, however, some plan is worked out whereby the pure science or engineering student of marked mathematical ability is given a chance to develop that ability, or the mathematical student with a tendency to applied mathematics is given opportunity in that direction, the sooner

will come the time of fullness of the development of applied science.

Mathematics has been a well-nigh indispensable tool in the development of the natural sciences and their applications. On the other hand the natural sciences and particular problems set by science have challenged the ability of mathematicians and spurred them on to the achievement of larger results in pure mathematics. Whoever can strike this flint of mathematics upon the steel of natural science and produce fire is doing the world service. The oftener fire is produced the greater will be the development of both mathematics and natural science.

THOS. E. MASON

PURDUE UNIVERSITY

EDUCATION AFTER THE WAR

THE sharp debate on the place of science in education which took place recently in the House of Lords between Lord Haldane on the one side and Lord Cromer and Viscount Bryce on the other side is an example of the kind of misunderstanding which it is necessary to eliminate if we here in the United States and you in England are to act wisely in the matter of education after the war.

In his sesquicentennial address at Princeton University nineteen years ago Woodrow Wilson said that if he was not mistaken the "scientific spirit" of the age is doing us a great disservice, working in us a certain great degeneracy; and yet he said that he had no indictment against science itself, but only a warning to utter against the atmosphere which has stolen from our laboratories and lecture rooms and into the general air of the world at large. It is a noxious intoxicating gas which has somehow got into the lungs of the rest of us, a gas which it would seem forms only in the outer air.

Now it is not easy even for one of Dr. Wilson's training to express himself with perfect clearness in a matter of this kind; and although we are in full sympathy with what we understand Dr. Wilson's point of view to be, we do not like his use of the term "scientific spirit." The true scientific spirit, the spirit of such men as Kelvin and Helmholtz, is beyond criticism; but the great things such men have done have brought upon us the most distressing and stupid form of idolatry the world has ever seen, and the men who have the true scientific spirit are the only men, as a rule, who are free from it.

Science is *finding out* and *learning how,* whereas most people think of science only in terms of its material results. These results have indeed fascinated the crowd, and the great majority of men have adopted a scale of physical values for everything in life "with a consequent neglect of quality and a denial of human value in everything. We have a philosophy of rectangular beatitudes and spherical benevolences, a theology of universal indulgence, a jurisprudence which will hang no rogues; all of which means, in the root, incapacity of discerning worth and unworth in anything and least of all in man. Whereas, nature and heaven command us, at our peril, to discern worth from unworth in everything and most of all in man."

"Our real problem now, as always, is 'Who is best man?' and the fates forgive much—forgive the wildest, fiercest and crudest experiments—if fairly made in the settling of that question. Theft and blood-guiltiness are not pleasing in their sight, and yet the favoring powers of the spiritual and material worlds will confirm to you your stolen goods, and their noblest voices applaud the lifting of your spear and rehearse the sculpture of your shield, if only your robbing and slaying have been done in fair arbitrament of that question 'Who is best man?' But if you refuse such inquiry you will come at last to face the same question wrong side upwards, and your robbing and slaying must then be done to find out 'Who is *worst* man?' which in so wide an order of inverted merit is indeed not easy."

This impassioned statement of a great English writer and moralist seems to us to touch the essence of all unfriendliness towards the sciences among seriously thoughtful men, and although this unfriendliness is largely mis-

directed it must be admitted that "side by side with great advances in material prosperity due largely to the applications of science there has been a vast deterioration of character," as Lord Cromer expressed it.

Indeed Lord Cromer applied his statement particularly to the Germans, but the deterioration of character, which has shown itself chiefly in the misuse of wealth and opportunity, is by no means confined to the Germans. In some respects, indeed, it would seem that the English and our own Americans have sinned more than the Germans.

Lord Haldane and all champions of science teaching should understand that most of the unfriendliness towards science is a hatred of material worship; and Lord Cromer and Viscount Bryce should understand that in their opposition to the extension of science teaching they are misdirecting their hatred of idolatry, and placing themselves in exactly the position of the hand spinners when they opposed the introduction of improved machinery years ago. It is now as much of a mistake to oppose the fullest and widest possible development of finding out and learning how as it was years ago to oppose labor-saving machinery; only it is quite necessary to make readjustments for the conservation of character and morals. Indeed this necessity has shown itself most distinctly in our reluctance to make just such readjustments among those whose labor has been so wonderfully "saved" by machinery!

In the early days at the University of Kansas (where one of us graduated thirty years ago) when the crudities of pioneer living were still very much in evidence the question was frequently raised among the young men of the faculty who had come from older communities in the east "Can the finer aspects of civilization, literature and the fine arts, ever flourish in this prairie country?" And a smaller faculty group, sensitized by the raw conditions, were very much alive to the question which has been fought over in every college "This new thing, science, what menace does it hold for literature and the fine arts?" Let one consider what must have been the state of mind of an immigrant group of intellectuals in grasshopper times in Kansas!

Nothing, perhaps, is farther from the ideals and methods of the mathematical sciences than literature and music and painting and sculpture, and yet many of our greatest scientists and engineers have held the artistic temperament to be the most important qualification for the investigator or builder. It certainly is not foolish, at any rate, to consider seriously the unfriendliness towards science teaching among those whose work is more closely connected with human things. Lord Cromer and Viscount Bryce no doubt agree with Woodrow Wilson in having no indictment against science itself, but they seem somehow to be unfriendly towards science teaching.

> Da wird der Geist Euch wohl dressirt
> In spanische Stiefeln eingeschnuert.

Indeed there is a phase of science teaching for which there is an unfriendly feeling among those whose work is closely connected with experimental science and engineering, namely, formal mathematics teaching, and nothing has ever been said which can be more justly applied in criticism of our conventional courses in mathematics than the following criticism of conventionalized art. The criticism is expressed in terms of the contrast between the two paths of art and it is illustrated by examples chosen from early barbarisms.

> The substitution of conventionalism for sympathy with observed life is the first characteristic of the hopeless work of all ages, and it is emi-

FIG. 1. An angel of the eighth century. The beginnings of art in England.

> nently manifested in the accompanying picture of an angel from a psalter of the eighth century which is to be found in the library of St. John's College, Cambridge. This angel is a barbarism

from which nothing could emerge, for which no future was possible but extinction. It represents an utterly dead school of art which closed its eyes to natural facts (for however ignorant a person may be he need only look at a human being to see that it has a mouth as well as eyes) and made the attempt to adorn or idealize natural facts according to its own notions (for it put red spots in the middle of the hands and sharpened the thumbs, thinking to improve them). Here you have an example of the worst that is possible in idealism. Whenever people don't look at nature they always think they can improve her.

From this dead barbarism let us turn to a living barbarism, to work done by hands as rude and by minds as uninformed, let us turn to a picture of the Serpent Beguiling Eve, from the Church of St. Ambrogio of Milan. Its date is not known, but it is barbarous enough for any date: but rude and ludicrous as the sketch is, it does certainly have the elements of life in it. The workman's whole aim was straight at the facts, and not merely at the facts but at the very heart of the facts, for he did indeed show Eve's state of mind, that she is pleased at being flattered and yet in an uncomfortable mood of hesitation; some look of listening, of complacency and embarrassment he did verily get into the picture; note the eyes slightly

FIG. 2. The Serpent Beguiling Eve. The beginnings of art in Italy.

askance, the lips compressed and the right hand nervously grasping the left arm. Nothing was impossible to the people who began their art thus. The world was open to them and all that is in it; whereas nothing was possible to the man who did the symmetrical angel, the world was keyless to him. He built a cell for himself in which he was barred up forever.

Our conventionalized courses in mathematics do not, however, take strong enough hold on young men to shut them up, as in a cell, forever! No, they certainly do not! But these courses do tend to separate ordinary mathematical ideas from sense material: whereas the very essence of physics and chemistry is to develop mathematical ideas in connection with sense material.

Let no one imagine that we, in our unfriendliness towards conventional mathematics teaching fail to appreciate the necessity of the kind of precise thinking which is peculiar to the mathematical sciences, although much that has been said on this subject by mathematicians seems to us to be only a near-vision of that abstract heaven which, according to William James, is the one refuge of tender-minded philosophers, but which to the tough-minded is merely an empty dream.

Nothing in this world is necessary which can be avoided, and it is much better to attempt to show that we can not get along without precise thinking than it is to pronounce eulogy thereon; and if one speaks of the necessity of precise ideas as a distressing thing, which it certainly is to many young men who aspire to be engineers and scientists, one may as it were by stealth gain entrance to their primitive minds and convince them that men do not now live by hunting and fishing. This is what we have tried to do in our "Introduction to Mechanics."[1]

Imagine a never-to-be-escaped human need of a twenty-foot arm. What age-long development, and what unthinkable pains! It is easier to build a steam shovel! All of which means that *homo sapiens* is now bent towards social inheritance; but social inheritance has its own pains, as many know who burn the midnight oil.

Weh dem die Enkeln sind.[2]

How shocking to reduce the tender-minded philosopher's love for perfect precision to a materialistic preference for steam shovels as

[1] See our "Mechanics and Heat," The Macmillan Co., 1910. This essay is reprinted under the title The Study of Science in "Bill's School and Mine," published by Franklin, MacNutt and Charles, South Bethlehem, Pennsylvania, 1913.

[2] This was addressed by Goethe directly to a young student "Weh dir das du ein Enkel bist."

opposed to immeasurable pains of birth! And to make mathematical philosophy appear as a dire necessity rather than a thing to be chosen for its own sake.[3] And then to urge[4] with that lover of paradox, Gilbert Chesterton, that the serious spiritual and philosophic objection to steam shovels is not that men work at them and pay for them and make them very ugly, nor even that men are killed by them, but merely that men do not play at them! Imagine a group of sportsmen cavorting over a ten-thousand acre field tossing and catching a Brobdignagian ball in steam shovels! Is it conceivable that the one objection to the steam shovel might have been eventually overcome if the Great War had not come upon us?

The greatest danger of our time is the confusion of boundaries between thing-philosophy and human-philosophy, between the philosophy of material conquest and power and that intimate philosophy of comfort which makes life not easy but worth while. When these boundaries are rectified there will be a philosophy of steam shovels recognized and used as such, and another philosophy of living; and the most laughable spectacle in the world will have passed by forever, namely, the Bergson type of philosopher with his following flock of men and women captivated by humbug in the name of an easy, capital-letter science raised heaven-high above all dirt and slime!

W. S. FRANKLIN,
BARRY MACNUTT

[3] This we have tried to do in our "Introduction to Mechanics."

[4] See preface to Franklin and MacNutt's "Elements of Electricity and Magnetism," The Macmillan Co., 1908.

THE VALUE OF THE SANITARY SURVEY

IT would seem unnecessary to again dwell upon the old topic that analytical examinations, whether chemical or bacteriological or both, utterly fail in a large number of cases to supply sufficient data whereon to build an opinion as to the sanitary value of a water; but the old belief is deep-seated and dies hard. From time to time therefore it appears necessary to call attention to the fact that, however valuable the information gained in the laboratory may be, a thorough personal knowledge of the conditions surrounding the source whence the water comes and the method used for taking the sample entirely outweigh the analytical data.

Take an instance: Mr. N. S. Hill had reported to him the presence of *B. Coli* in water from flowing artesian wells, over which wells he had jurisdiction; and he was naturally not a little pained and mystified because of the character of such report, the accuracy of which was beyond dispute. The water rose under pressure sufficient to carry it fifteen or twenty feet above the ground surface and it thence fell in open streams into the funnel-shaped ends of vertical pipes connected directly with the supply main. Deep waters may contain bacteria, especially chromogenic varieties, and even pathogenic forms may occur therein because of unsuspected channel ways in the rock; but under the conditions obtaining in this instance the adverse report of the examiner was unlooked for and Mr. Hill's surprise was fully warranted.

Upon carefully conducted inspection it was observed that at certain times of the day the rims of the above-mentioned funnel-shaped pipe terminals were lined with sparrows that roosted, as often as not, with heads pointed outward.

Another case of pollution due to birds had a more serious ending. The contractor was confident of the purity of the water he had engaged to supply and rested his case upon the report of a bacteriologist selected by both parties. The report was adverse to the fitness of the water and caused financial failure of the contractor. When it was too late to rectify the error it was discovered that the small basin which caught the water as delivered from the ground had served as a roosting place for birds and from that basin, rather than from the falling stream, the sample had been taken.

During a legal inquiry concerning what could or could not be done by the addition of alum to a city water-supply, much discussion

was had over the disadvantage or otherwise of using the chemical and considerable excitement followed its detection at the city faucets. Material doubt was afterwards thrown upon the accuracy of the determination and upon what may be termed "prophetic taste" when it was noted that the presence of alum had been detected some four days before it was added to the raw water.

A large town was desperately in need of water and an excellent ground supply was located. The health officer, a physician who was not in favor of the proposed plan, sampled the water, carried the sample under his buggy seat during his professional visits in the country and in the course of a day or two forwarded it, by express, without ice packing, to the central authorities who condemned it upon the strength of the high count of bacteria without having ever visited the well.

An outbreak of typhoid fever manifestly due to transmission by flies occurred in a city during a period when certain repairs were being made to the conduit leading from the source of the public water. Outside authorities to whom the situation was referred reported the outbreak of disease as probably caused by the entrance of the repair gang into the tunnel carrying the municipal supply. A visit to the spot would have convinced the writers of the report of the impossibility of getting the said gang into the twenty-inch cast-iron pipe.

The duties of the water examiner, however, do not always limit him to use the sanitary survey to save a good water from unfair condemnation. Quite otherwise. A water of entirely satisfactory character judged from the laboratory standpoint may be rated as undesirable upon inspection of local conditions because of proposed changes in the immediate vicinity of the source.

A spring water of high quality was condemned because arrangements had been made to construct a sewer above the spring and near it. The engineer in charge was to construct a "tight sewer," but who could guarantee that it would stay tight? A glance at the tables showing the leakage of ground water into sewers should shake one's faith in the permanence of such "tightness," and sewers not tight can allow of leakage out as well as in.

Damage to water through "new construction" is very fruitful of adverse and unfair reports. Springs of unassailable purity become temporarily injured (solely from the laboratory standpoint) because of "developments" made with a view to improve the surroundings. New wells and recently "improved" springs will furnish waters likely to be condemned by laboratory standards and samples of their waters should therefore not be submitted for examination.

Finally, while it is admitted that laboratory methods of water analysis have made great strides towards perfection during recent years, they can never hope to reach such perfection as to enable the analyst to uniformly rest upon chemistry and bacteriology alone, without aid from the actual sanitary survey, and they can still less be depended upon to furnish information not on what a water is, but on what it is likely to become.

W. P. Mason

Troy, N. Y.,
September 25, 1916

THE CONVOCATION-WEEK MEETINGS OF SCIENTIFIC SOCIETIES

The American Association for the Advancement of Science and the national scientific societies named below will meet at New York City, during convocation week, beginning on Tuesday, December 26, 1916:

American Association for the Advancement of Science.—President, Charles R. Van Hise, president of the University of Wisconsin; retiring president, Dr. W. W. Campbell, director of the Lick Observatory; permanent secretary, Dr. L. O. Howard, Smithsonian Institution, Washington, D. C.; general secretary, Professor W. E. Henderson, Ohio State University; secretary of the council, Dr. C. Stuart Gager, Brooklyn Botanical Garden.

Section A—Mathematics and Astronomy.—Vice-president, Professor L. P. Eisenhart, Princeton University; secretary, F. R. Moulton, University of Chicago, Chicago, Ill.

Section B—Physics.—Vice-president, Professor H. A. Bumstead, Yale University; secretary, Dr.

W. J. Humphreys, U. S. Weather Bureau, Washington, D. C.

Section C—Chemistry.—Vice-president, Professor Julius Stieglitz, University of Chicago; secretary, Dr. John Johnston, Geophysical Laboratory, Washington, D. C.

Section D—Mechanical Science and Engineering.—Vice-president, Dr. H. M. Howe, Columbia University; secretary, Professor Arthur H. Blanchard, Columbia University, New York City.

Section E—Geology and Geography.—Vice-president, Professor R. D. Salisbury, University of Chicago; secretary, Professor George F. Kay, University of Iowa.

Section F—Zoology.—Vice-president, Professor G. F. Parker, Harvard University; secretary, Professor Herbert V. Neal, Tufts College, Mass.

Section G—Botany.—Vice-president, Dr. C. Stuart Gager, Brooklyn Botanical Garden; secretary, Dr. A. F. Blakeslee, Cold Spring Harbor, N. Y.

Section H—Anthropology and Psychology.—Vice-president, Dr. F. W. Hodge, Bureau of American Ethnology; secretary, Professor George Grant MacCurdy, Yale University, New Haven, Conn.

Section I—Social and Economic Science.—Vice-president, Louis F. Dublin, Metropolitan Life Insurance Company; secretary, Seymour C. Loomis, 69 Church Street, New Haven, Conn.

Section K—Physiology and Experimental Medicine.—Vice-president, Professor Edwin O. Jordan, University of Chicago; secretary, Professor C.-E. A. Winslow, Yale University.

Section L—Education.—Vice-president, Dr. L. P. Ayres, The Russell Sage Foundation; secretary, Dr. Stuart A. Courtis, Detroit, Mich.

Section M—Agriculture.—Vice-president, Dr. W. H. Jordan, director of the New York Agricultural Experiment Station; secretary, Dr. E. W. Allen, U. S. Department of Agriculture, Washington, D. C.

American Mathematical Society.—December 27 and 28. President, Professor Ernest W. Brown, Yale University; secretary, Professor F. N. Cole, 501 West 116th St., New York, N. Y.

Mathematical Association of America.—December 28, 29 and 30. President, Professor E. R. Hedrick, University of Missouri; secretary, W. D. Cairns, 5465 Greenwood Ave., Chicago, Ill.

American Astronomical Society.—December 26 to 30. President, Dr. E. C. Pickering, Harvard College Observatory; secretary, Dr. Philip Fox, Dearborn Observatory, Evanston, Ill.

American Federation of Teachers of the Mathematical and the Natural Sciences.—Council meeting. Secretary, W. A. Hedrick, Central High School, Washington, D. C.

American Physical Society.—December 26 to 30. President, Professor R. A. Millikan, University of Chicago; secretary, Professor Alfred D. Cole, Ohio State University, Columbus, Ohio.

Optical Society of America.—December 28. President, Dr. Perley G. Nutting, 3 Kodak Park, Rochester, N. Y.

American Chemical Society.—President, Dr. Charles H. Herty, New York City; secretary, Dr. C. L. Parsons, U. S. Bureau of Mines, Washington, D. C.

American Electrochemical Society.—Chairman, New York Section, Dr. Colin G. Fink, Edison Lamp Works, Harrison, N. J.

Society for the Promotion of Engineering Education.—President, Professor H. S. Jacoby, Columbia University; secretary, Professor F. L. Bishop, University of Pittsburgh, Pittsburgh, Pa.

Illuminating Engineering Society.—President, W. J. Serrill; chairman, Committee on Reciprocal Relations, Clarence L. Law, Irving Place and 15th St., New York, N. Y.

Association of American Geographers.—December 28 to 30. President, Dr. Mark Jefferson, Michigan State Normal College, Ypsilanti, Mich.; secretary, Professor Isaiah Bowman, Yale University, New Haven, Conn.

American Alpine Club.—December 30. President, H. G. Bryant; secretary, Howard Palmer, New London, Conn.

American Society of Naturalists.—December 29. President, Dr. Raymond Pearl, Maine Agricultural Experiment Station; secretary, Professor Bradley M. Davis, University of Pennsylvania, Philadelphia, Pa.

American Society of Zoologists.—December 27, 28 and 29. President, Professor D. H. Tennent, Bryn Mawr College; secretary, Professor Caswell Grave, Johns Hopkins University, Baltimore, Md.

Entomological Society of America.—December 26 and 27. President, Dr. E. P. Felt; secretary, J. M. Aldrich, West Lafayette, Ind.

American Association of Economic Entomologists.—December 28, 29 and 30. President, Dr. C. Gordon Hewitt, Department of Agriculture, Ottawa, Canada; secretary, Albert F. Burgess, Melrose Highlands, Mass.

AMERICAN GENETIC ASSOCIATION.—December 26, 27 and 28. President, David Fairchild, U. S. Department of Agriculture; secretary, George M. Rommel, 511 11th St., Washington, D. C.

EUGENICS RESEARCH ASSOCIATION.—President, Professor Adolf Meyer, The Johns Hopkins University; secretary, William F. Blades, 191 Haven Ave., New York, N. Y.

ECOLOGICAL SOCIETY OF AMERICA.—December 27, 28 and 29. President, Professor V. E. Shelford, University of Illinois; secretary, Forrest Shreve, Desert Botanical Laboratory, Tucson, Ariz.

BOTANICAL SOCIETY OF AMERICA.—December 27 to 30. President, Professor R. A. Harper, Columbia University; secretary, Dr. H. H. Bartlett, University of Michigan, Ann Arbor, Mich.

AMERICAN PHYTOPATHOLOGICAL SOCIETY.—December 27 to 30. President, Dr. Erwin F. Smith, U. S. Department of Agriculture; secretary, Dr. C. L. Shear, U. S. Department of Agriculture, Washington, D. C.

AMERICAN FERN SOCIETY.—December 29. President, Dr. C. H. Bissell, Michigan Agricultural College; secretary, C. A. Weatherby, 920 Main St., East Hartford, Conn.

SULLIVANT MOSS SOCIETY.—December 29. President, Mrs. Elizabeth G. Britton, N. Y. Botanical Garden; secretary, Edward B. Chamberlain, 18 West 89th St., New York, N. Y.

SOCIETY OF HORTICULTURAL SCIENCE.—December 28, 29. Secretary, C. P. Close, U. S. Department of Agriculture, Washington, D. C.

ASSOCIATION OF OFFICIAL SEED ANALYSTS.—Will meet on dates to be announced. Secretary, John P. Helyar, New Brunswick, N. J.

SOCIETY OF AMERICAN FORESTERS.—Meets on Friday, December 29. President, Dr. B. E. Fernow, University of Toronto; secretary, C. R. Tillotson, U. S. Forest Service, Washington, D. C.

MID-WEST FORESTRY ASSOCIATION.—President, Fred W. Smith, State School of Forestry, Bottineau, N. Dak.

AMERICAN MICROSCOPICAL SOCIETY.—Business sessions. President, Professor M. F. Guyer, University of Wisconsin; secretary, Professor T. W. Galloway, Beloit College, Beloit, Wis.

AMERICAN ANTHROPOLOGICAL ASSOCIATION.—December 26 to 29. President, Dr. F. W. Hodge, Bureau of American Ethnology; secretary, Professor George G. MacCurdy, Yale University Museum, New Haven, Conn.

AMERICAN FOLK-LORE SOCIETY.—December 27. President, Dr. R. H. Lowie, American Museum of Natural History; secretary, Charles Peabody, Harvard University, Cambridge, Mass.

AMERICAN PSYCHOLOGICAL ASSOCIATION.—December 27 to 30. President, Professor Raymond Dodge, Wesleyan University; secretary, Professor R. M. Ogden, Cornell University, Ithaca, N. Y.

AMERICAN PHILOSOPHICAL ASSOCIATION.—December 27, 28 and 29. President, Professor A. O. Lovejoy, The Johns Hopkins University; secretary, Professor E. G. Spaulding, Princeton University, Princeton, N. J.

AMERICAN SOCIETY OF BACTERIOLOGISTS.—December 29. Secretary, A. P. Hitchens, Glen Olden, Pa.

AMERICAN ASSOCIATION OF ANATOMISTS.—December 27, 28 and 29. President, Dr. H. H. Donaldson, Wistar Institute of Anatomy; secretary, Professor C. R. Stockard, Cornell Medical School, New York, N. Y.

AMERICAN PHYSIOLOGICAL SOCIETY.—December 27, 28, 29 and 30. President, Professor W. B. Cannon, Harvard Medical School; secretary, Professor Charles W. Greene, University of Missouri, Columbia, Mo.

AMERICAN SOCIETY OF BIOLOGICAL CHEMISTS.—December 27, 28 and 29. President, Professor Walter Jones, The Johns Hopkins University; secretary, Dr. Stanley R. Benedict, Cornell Medical College, New York, N. Y.

AMERICAN SOCIETY FOR PHARMACOLOGY AND EXPERIMENTAL THERAPEUTICS.—December 28, 29 and 30. President, Professor Reid Hunt, Harvard Medical School; secretary, Dr. John Auer, Rockefeller Institute, New York, N. Y.

AMERICAN SOCIETY FOR EXPERIMENTAL PATHOLOGY.—December 28, 29 and 30. President, Simon Flexner, The Rockefeller Institute; secretary, Dr. Peyton Rous, Rockefeller Institute, New York, N. Y.

(*The above four societies compose the Federation of American Societies for Experimental Biology. Executive Secretary, Dr. Peyton Rous.*)

AMERICAN NATURE-STUDY SOCIETY.—December 27. President, Professor L. H. Bailey, Ithaca, N. Y.; secretary, E. R. Downing, University of Chicago, Chicago, Ill.

SCHOOL GARDEN ASSOCIATION OF AMERICA.—December 29 and 30. President, Van Evrie Kilpatrick, 124 West 30th St., New York, N. Y.

Gamma Alpha Graduates Scientific Fraternity.—Will meet on dates to be announced. President, Professor W. J. Meek, University of Wisconsin; recorder, L. C. Johnson, 2018 Madison St., Madison, Wis.

Society of the Sigma Xi.—December 27. President, Dr. Charles S. Howe, Case School of Applied Science; secretary, Professor Henry B. Ward, University of Illinois, Urbana, Ill.

American Association of University Professors.—December 29 and 30. President, Dr. John H. Wigmore, Northwestern University; secretary, Dr. H. W. Tyler, Massachusetts Institute of Technology.

SCIENTIFIC NOTES AND NEWS

The following is a list of those recommended by the president and council of the Royal Society for election at the anniversary meeting on November 30: *President,* Sir J. J. Thomson, O.M., M.A., D.Sc., LL.D.; *Treasurer,* Sir A. B. Kempe, M.A., D.C.L.; *Secretaries,* Professor A. Schuster, Sc.D., Ph.D., and W. B. Hardy, M.A.; *Foreign Secretary,* Professor W. A. Herdman, D.Sc.; *Other Members of the Council,* Professor J. G. Adami, M.D., H. T. Brown, LL.D., Dugald Clerk, D.Sc., Professor A. R. Cushny, M.D., Professor A. Dendy, D.Sc., Professor P. F. Frankland, LL.D., Professor J. W. Gregory, D.Sc., H. Head, M.D., J. H. Jeans, Major H. G. Lyons, Major P. A. McMahon, D.Sc., Professor F. W. Oliver, D.Sc., Professor C. S. Sherrington, M.D., Professor A. Smithells, B.Sc., Hon. R. J. Strutt, M.A., and R. Threlfall, M.A.

As has been noted in Science Dr. Wilhelm Waldeyer, professor of anatomy at the University of Berlin since 1883, was raised to the hereditary peerage on the occasion of his eightieth birthday on October 6. The *Journal* of the American Medical Association states that a bronze portrait plaque was presented to him by his present and former pupils, and a duplicate was hung in the headquarters of the Postgraduate Instruction System. He has been chairman of the central committee of this work for many years. The Leopold-Karolinische Akademie of Halle presented him with the gold Cothenius medal, and honorary memberships in various scientific and other societies poured in on him. He announced that although he was thinking of retiring from his teaching chair at the university at the close of this semester, yet he intended to keep up his other work.

Sir Frank Dyson, astronomer royal, Professor R. A. Sampson, astronomer royal for Scotland and professor of astronomy in the University of Edinburgh, and Professor H. C. Plummer, astronomer royal of Ireland and Andrews professor in the University of Dublin have been elected honorary members of the British Optical Society.

Dr. Henry Head, F.R.S., physician to the London Hospital and editor of *Brain,* has been added to the government committee which, under the chairmanship of Sir J. J. Thomson, president of the Royal Society, is inquiring into the position occupied by natural science in the educational system of Great Britain, especially in secondary schools and universities.

At a recent meeting of the Royal Astronomical Society, Mrs. R. A. Proctor, widow of the astronomer Richard A. Proctor, was formally admitted as fellow of the society. Exactly 50 years ago, in November, 1866, the late Richard A. Proctor was elected to fellowship.

The University of London has awarded the Rogers prize of £100 for 1916, for an essay on "The Nature of Pyrexia and Its Relation to Microorganisms" to Dr. J. L. Jona.

The trustees of the Massachusetts Horticultural Society have awarded the George Robert White Medal of Honor for the year 1916 to William Robinson, of Gravetye Manor, Sussex, England. The medal, by John Flanagan, is of coin gold, weighs 8½ ounces and was struck at the mint of the United States, Philadelphia. This is the eighth award of this medal made by the society in recognition of eminent service in the advancement of horticulture. Previous awards have been made to Professor C. S. Sargent, of the Arnold Arboretum; Jackson T. Dawson, Victor Lemoine, of Nancy, France; Michael H. Walsh, the rose specialist of Woods Hole; Sir Harry J. Veitch, of London, and Ernest H. Wilson. William Robinson, to whom the medal is now

awarded, has done much, especially through his writings in horticultural literature, as an exponent of the natural style of flower gardening as opposed to the formal bedding and ribbon borders of former years.

THE *Frankfurter Zeitung*, as quoted by the *Journal* of the American Medical Association, has published a statement to the effect that Professor W. Kolle, chief of the Institute for Bacteriology and Hygiene of the University of Bern, has been called to Frankfurt as successor to Ehrlich in the Institute for Experimental Therapy and also in the G. Speyer-Haus. Professor Wassermann, of Berlin, was called first, but he yielded to pressure from the local scientific authorities and finally declined. Professor Hans Sachs, Ehrlich's coworker, has been appointed director of the Institute for Experimental Therapy, and Professor Morgenroth of the Charité, Berlin, is being considered for director of the Speyer Institute.

PROFESSOR A. S. HITCHCOCK, systematic agrostologist, U. S. Department of Agriculture, has returned from a five months' tour of the Hawaiian Islands. He explored in considerable detail the islands of Hawaii, Maui, Molokai, Lanai, Oahu and Kauai, and brought back important collections of plants. He was accompanied by his son, Albert E. Hitchcock, as assistant.

DR. WAICHIRO OCADO, professor of medicine at the University of Tokyo, is making a tour of inspection of the hospitals of the United States.

AT the meeting of the Royal Statistical Society held on November 21, the president, Sir Bernard Mallet, delivered his presidential address on "The Organization of Registration in its Bearing on Vital Statistics."

THE Mineralogical Society, London, has elected the following officers: *President*, Mr. W. Barlow; *Vice-presidents*, Professor H. L. Bowman and Mr. A. Hutchinson; *Treasurer*, Sir William P. Beale, Bart.; *General Secretary*, Dr. G. T. Prior; *Foreign Secretary*, Professor W. W. Watts; *Editor of the Journal*, Mr. L. J. Spencer.

THE Geographical Society of Philadephia celebrated the twenty-fifth anniversary of its founding at the Academy of Natural Sciences on Wednesday evening, December 6. The address of welcome was given by Dr. Samuel G. Dixon, president of the Academy of Natural Sciences, and addresses were made on "Men and Memories of the Early Days of the Society" by Mr. Henry G. Bryant, president of the Geographical Society, and on "Past and Future of the Society," by Dr. Talcott Williams, director of the school of journalism, Columbia University. A reception was held afterwards in the Library Hall of the academy.

DR. W. F. HILLEBRAND, chief chemist of the Bureau of Standards, Washington, D. C., lectured at Columbia University, on November 27, on "Analytical Chemistry and Its Possible Future." This was the second lecture on the Chandler Lecture Fund which was established by former students of the university in honor of Dr. C. F. Chandler, Mitchell professor emeritus of chemistry.

DR. HENRY H. DONALDSON, of the Wistar Institute of Anatomy, will give the fourth Harvey lecture in the New York Academy of Medicine on the evening of December 16. The subject of the lecture is "Growth Changes in the Mammalian Nervous System."

A BUST of John Muir was unveiled at the University of Wisconsin on the evening of December 6. The bust was presented by Mr. T. E. Brittinham to the university where Muir was a student for four years. Dean E. A. Birge presided, and addresses were made by Regent Charles H. Villas and President Charles R. Van Hise.

IN the eighth Kelvin lecture, delivered before the Institution of Electrical Engineers, Dr. Alexander Russell dealt with some aspects of his subject's life and work which are of special interest to engineers.

AN exhibition and sale of water-color sketches by the late Professor Silvanus P. Thompson, the distinguished physicist, was held at the rooms of the Alpine Club, London, from November 27 to December 10.

It is planned to erect at the University of Vermont a memorial to the late Professor N. S. Merrill, of the department of chemistry. A committee for this purpose has been appointed by the Alumni Association with Professor E. C. Jacobs as chairman.

The graduating class of the Long Island College Hospital presented to the college, on December 4, a photographic portrait of the late Dr. Joseph H. Raymond, formerly secretary of the faculty and professor of hygiene. Dr. John D. Rushmore made the address of acceptance.

Dr. Martin I. Wilbert, assistant in the division of pharmacology of the hygienic laboratory, died suddenly in Philadelphia on November 25. By virtue of his work in the preparation of "The Digest of Comments on the U. S. Pharmacopoeia and National Formulary" and his services in the American Medical Association and the American Pharmaceutical Association, Dr. Wilbert was among the most influential men in his profession.

Charles Alfred Pitkin, professor of mathematics and physics at Thayer Academy, South Braintree, since its opening in 1877, died on November 5, aged sixty-three years.

The death is announced, at the age of sixty-eight years, of Dr. C. A. Harrison, for many years engineer in chief of the Northeastern Railway of Great Britain.

C. S. Hägler, a leading surgeon and bacteriologist of Basel, Switzerland, connected with the university but prevented by deafness from a full professorship, has died from cancer, at the age of fifty-four years.

K. B. Pontoppidan, professor of nervous and mental diseases and later of forensic medicine at the University of Copenhagen, has died at the age of sixty-three years. He was one of the pioneers in the modern treatment of the insane, and has been at the head of the Aarhus asylum since 1898.

The trustees of the Elizabeth Thompson Science Fund announce their readiness to consider applications for grants in aid of scientific work. Appropriations are restricted to non-commercial enterprises, and are intended solely for the actual expenses of the investigation, not for the support of the investigator nor for the ordinary costs of publication. Grants are made only for those researches, not otherwise provided for, whose object is broadly the advancement of human knowledge; requests for researches of a narrow or merely local interest will not be considered. Usually grants are not made in excess of three hundred dollars. Applications for grants from this fund should be accompanied by a full statement of the nature of the investigation, of the conditions under which it is to be prosecuted, and of the manner in which the appropriation asked for is to be expended. The application should be sent to the secretary of the board of trustees, Dr. W. B. Cannon, Harvard Medical School, Boston, Mass., who will furnish further details.

The University of Washington campus has been selected as the site of the government mining and metallurgical station for the Pacific Northwest states. Congress has voted an appropriation of $25,000 a year for the maintenance of the station which will serve Washington, Oregon, Idaho, Montana and the coastal regions of Alaska from Ketchikan to Nome. The interior of Alaska will be served by a Fairbanks station. Dorsey A. Lyon, a graduate of Leland Stanford, Jr., University, formerly professor of mining engineering at the University of Washington, a specialist in electro-metallurgy, will be in charge of the station.

We learn from the *Journal of Industrial and Engineering Chemistry* that Director Joseph E. Ralph, of the U. S. Bureau of Engraving and Printing, has made public the plan of the Bureau of Chemistry in its establishment of an experimental dye laboratory, for which Congress appropriated $50,000, the location of which will be on the government's property in Virginia just across the Potomac from Washington. Director Ralph has arranged with Dr. Alsberg to give a practical test to all the colors produced by this experimental laboratory.

Bequests of more than $100,000 each have been left to the Metropolitan Museum of Art

and the American Museum of Natural History by the late James Gaunt, American representative of A. & F. Pears, of London. The bequests are to be paid upon the death of Mr. Gaunt's brother.

UNIVERSITY AND EDUCATIONAL NEWS

THE Carnegie Corporation of New York has appropriated $1,038,500 for the use of the Carnegie Institute, Pittsburgh, according to an announcement made at a meeting of the board of trustees by Mr. Samuel H. Church, the president. The Carnegie Institute of Technology will receive $956,000, while $52,500 will be used for the improvement of the Museum of Fine Arts department and the Carnegie Library School, and $30,000 for contingent expenses. The appropriation makes the total benefaction of Mr. Andrew Carnegie in this connection $28,000,000.

MR. JAMES A. PATTEN, vice-president of the board of trustees of Northwestern University, has made a gift of $134,000 to the university. Of this sum $74,000 will be used as an endowment for the gymnasium, of which Mr. Patten is the donor, and $60,000 as a loan fund for students.

IT is announced from Swansea that Messrs. Baldwins (limited) have given £10,000 to the Technical College there for the endowment of a chair of metallurgy.

THE Chemical Institute of the University of Munster has recently been enlarged and has received an endowment for research. The Prussian parliament voted an appropriation for the purchase of machinery, books and other equipment and a number of metal and dynamic firms have raised additional sums.

THE research departments of Johns Hopkins Medical School are being transferred to the new Hunterian Laboratory Building, located at the corner of Wolfe and Madison Streets. The building is five stories in height, constructed of red brick with sandstone trimmings, and will house the school library and all research laboratories.

THE Case School of Applied Science has arranged an extended course in illuminating engineering with the cooperation of the National Lamp Association, a branch of the General Electric Company, with its headquarters in Cleveland.

THE building of the Indiana University School of Medicine at Indianapolis was damaged by fire on December 7, to the extent of $50,000. A meeting of the trustees has been called to decide whether it is advisable to restore the building or to erect a new building on the grounds of the Robert W. Long Hospital, which is under the control of the university.

ADDITIONS to the instructing staff at the Massachusetts Institute of Technology made by the corporation at its last meeting concerned very largely the new stations for the course in chemical engineering practise. The assistant professors and directors have already been announced; their assistants, who have the grade of instructors are: At Bangor, Wilfred Arthur Wylde; at Everett, William Butler Leach, Jr.; at Niagara Falls, Winthrop Earle Caldwell; at Stamford, Edwin Shellabarger Wallace, and at Allentown, Penna., John Shirley Little. Other appointments are: Frank C. Sheperd, lecturer on valuation of public service and other corporations in the department of civil engineering; Claire W. Ricker and Rudolph F. Zecha, instructors in electrical engineering; Edmond W. Bowler, research assistant in electrical engineering; Azel W. Mack, research assistant in applied chemistry, and Murray P. Horowitz, assistant in biology.

DR. H. H. LLOYD is lecturing on physical chemistry at the Johns Hopkins University, temporarily filling the vacancy caused by the death of Dr. Harry C. Jones.

J. F. WILSON, formerly instructor in electrical engineering at the University of Michigan, has been appointed professor of electrical engineering at Queen's University to take the work of Professor L. W. Gill while the latter is in active military service.

DISCUSSION AND CORRESPONDENCE

OPINIONS ON SOME CILIARY ACTIVITIES

In Science for August 4, 1916, Professor C. Grave has questioned the accuracy of some of my conclusions concerning the ciliary mechanisms of lamellibranchs, dealing with the ingestion of food, that were published in the *Journal of Morphology*, Vol. 26, No. 4.

Those statements of mine which he has difficulty in accepting are:

1. Volume alone determines whether the collected foreign matter that reaches the palps shall proceed to the mouth or shall be sent from the body on outgoing tracts of cilia.

2. A lamellibranch is able to feed only when waters are comparatively clear—when diatoms are brought to the gill surfaces a few at a time. In muddy waters all suspended particles, of whatever nature, are led to outgoing tracts.

3. There is no selection or separation of food organisms from other water-borne particles.

4. The direction of the beat of cilia is never changed.

The only facts bearing on these statements, that are offered from Professor Grave's own experience, are those derived from an oyster-feeding experiment made at Buzzards Bay, and these bear only on the second statement, namely, that lamellibranchs feed only when waters are comparatively free from suspended particles.

Professor Grave has referred fully enough for the purpose, to the litigation that led to his experiment. Planted oysters had died in great numbers at the mouth of the Monument River after dredging operations were begun in the oyster field, and below it in Buzzards Bay. He wished to show that oysters could live in the turbid water. Taking individuals gathered at a distance, he deprived them of food for three days, then at a certain point immersed them "in the turbid water" for periods of one, two and three hours, at the end of which periods their stomachs contained from 2,850 to 18,500 food particles. In some cases, also, there was so much sediment that a diatom count was not possible. Some oysters were allowed to remain on the bottom for two weeks, and "all thrived and made perceptible growth of shell."

My contention, based on thousands of examinations of the operation of the palps in very many species of lamellibranchs, and extending through many years, was that when solid particles in sufficient volume are brought to the apposed palp surfaces, they overflow the narrow tracts leading to the mouth from either side, so as to touch outgoing tracts that border them, and by these are carried away and eventually removed from the body. My assumption was that, in this particular case, waters had, during long intervals, been so laden with fine sand and bast fibers from decaying vegetable matter, liberated by the dredging operations, that oysters over the field in general had been, through the action of the ciliary mechanisms of the palps, so often deprived of nourishment that they were gradually weakened and finally destroyed. They were not killed at once, for during a part of the ebb tide relatively clear water coming down from flats above the bay presented conditions favorable for feeding. Some had remained alive for more than two years under the adverse conditions. Here and there even the young had grown for a time. The condition of the field in 1911 indicated, and the owners of the beds testified, that, in general, there had been a gradual elimination.

The results of Professor Grave's feeding experiment seems to him to "show conclusively that oysters can and did feed actively in waters that were turbid with sediment, a fact that is in direct opposition to Dr. Kellogg's conclusion numbered (2) in this paper [and in the present one], and one that casts doubt upon the correctness of the three other conclusions herein discussed."

During a period of two weeks, Professor Grave's oysters "thrived and made perceptible growth of shell." This is not a very full or definite statement of his net results in the matter of growth, but it is all that he has given. At the same time, it was the testimony of all the oyster planters, as well as my own, after I had examined their beds, that, far from thriving, a large proportion of their planted oysters had died, after several months—so

many that the oystermen had almost entirely abandoned the field, and sought other occupation. This fact was completely established. Professor Grave admits an "unusually large" death rate, adding that the "planters readily imagined that the poor condition and death of their oysters were in some way causally connected with this sediment in the water." Commissioners, then referees, and finally a jury, readily imagined the same thing, and awarded them damages for their losses. Why should Professor Grave's oysters have thrived while those of the oystermen died?

It is not without interest that the death of the planted oysters, and other lamellibranchs on the same ground, could not be accounted for by the presence of starfish, drills or other enemies, or from any disease. On the other hand, Professor Grave's oysters may have survived for two weeks, and added a "perceptible growth" to the shell for several possible reasons.

A few of the bed oysters had lived, not two weeks, but two years or more after dredging had begun. A good many survivors were found behind a bar that deflected one of the two main flood currents away from them. The accident of position may have been favorable to Professor Grave's oysters, but they would have lived much longer than two weeks anywhere on the beds.

During the summer of 1911, when this experiment was made, dredging was intermittent. Frequently so little of it was being done that the flood tides bore comparatively little sediment over the beds.

Again, at the time of this experiment most of the dredging was being done at a much greater distance from the beds than formerly, and the water was proved to bear very much less silt than in 1909 and 1910 when the mortality on the beds had been greatest. This fact alone should be sufficient to explain Professor Grave's result.

That oysters in good condition, "gathered from a bed far removed from the scene of the dredging operations," should fail in two weeks to become emaciated—or should thrive—was to be expected. Nor, considering the possible conditions, was I surprised at Professor Grave's results in his examination of the contents of their stomachs. I was not able to see that the fact that his oysters fed "in waters that were turbid with sediment" was at all in opposition to my conclusion. "Turbid with sediment" is a relative—a very indefinite—term. I believe that any lamellibranch is able to take into its stomach any suspended particles, sand grains as well as diatoms, even in turbid water, until a definite point is reached at which they become too numerous, and that then they are all carried out of the body. It is unfortunate that in my work on the ciliary mechanisms I have not determined precisely how turbid the water must be, that is, how large a proportion of suspended matter must be present, to bring the discharging mechanism into action; but in my experiments there was always such a point. Professor Grave asserts his disbelief even in the existence of a normal mechanism of this kind as I have described it, though I have no reason to think that he ever took the trouble to look for it. I am not particularly anxious over final judgment on that matter, or on the "Kellogg theory" of its operation.

The most interesting of Professor Grave's assumptions, however, concern food selection, and my statement that the beat of cilia is nowhere reversed. He contends that cilia of "certain tracts" of the palps are capable of being reversed, as in the case of the oyster, "resulting perhaps from their stimulation directly or indirectly by food particles," and that this "may be the mechanism by which the selection is effected."

One is a little puzzled to understand, from the statement of it, what is the mechanism and its operation according to the Grave theory. Does the reversal of cilia from stimulation by food particles cause the rejection of food particles? If so, to what purpose? Or does stimulation by *food* cause the rejection of *sand*, and not of food particles? That would be interesting. Professor Grave's theory credits the oyster with the possession of a delicate sense of taste, and he is rather scornful because mine does not. Does the taste of sand,

like the taste of crab juice in the case of *Metridium* mentioned by Professor Grave, cause its acceptance, or perhaps its rejection? He says only that food particles, and not that sand or other matter in suspension, cause the reversal that results somehow in the selection of something, either food or material not useful as food, it is difficult to determine which. I judge that some diatoms are rejected, and that other diatoms, and sand, are selected. *Rhizosolenia*, "abundant in salt water, are seldom found in the digestive tract of the oyster." They are not excluded on account of their spiny structure, we are told, because their size is not sufficiently great to prevent their being carried by cilia currents or entering the mouth. Has Professor Grave made observations to determine whether their spiny structure or size is great enough to cause their rejection by the outgoing tracts that, up to this time, I had supposed I had seen in a very great many instances? I must say that I have not, myself, in the case of this particular diatom; but I have seen certain other diatoms excluded, though not in the oyster.

And according to this view, it seems necessary to assume that sand is selected and sent into the mouth, for Professor Grave tells us that it is a "fact that the stomach contents of oysters always contain a larger volume of sand than of food organisms." I am grateful to him for adding that this is difficult to explain on the Kellogg theory. I am sure that he will not contend that everywhere, where oysters and other lamellibranchs "thrive," suspended sand is in greater volume than suspended diatoms. When it is not, do oysters select sand, and reject diatoms that are suitable for food? They must do the one thing or the other, or both, if sand is always to be more abundant than diatoms in their stomachs. It is difficult to understand how statements of this sort can so easily and confidently be made, and this one indicates how limited have been Professor Grave's studies on the stomach contents of oysters, to say nothing of those of other lamellibranchs. My own study of this subject has not been extensive, either, but I have material on hand to disprove this statement, if it is applied to the group of lamellibranchs in general. My "theory," that has been attacked, does not apply to the oyster alone, but to all lamellibranchs, most of which demonstrate it more clearly than the oyster does.

What may be called the argument of Professor Grave concerning the supposed reversal of the cilia beat on the palp tracts, with results that he makes no pretence of having observed, and has not formulated in his own mind, is based on the statement of Engelmann that he has actually witnessed this reversal on the palps of lamellibranchs, and on the facts that a reversal occurs in *Stentor* and other protozoa, and in *Metridium*, resulting in the selection of food and in the rejection of other particles.

I do not feel that I am in a position to object that even one who has never studied the matter himself should, without any question or hesitation, accept the statement of Engelmann and reject my own, on the matter of cilia reversal on the lamellibranch palp. "Why then," asks Professor Grave, after quoting Engelmann, "if a reversal of cilia and selection of food takes place in lamellibranchs, did Dr. Kellogg fail to see the reversal process?" The matter is settled at once; but I venture to suggest that somebody else should examine the palps of *Schizotherus*, of some species of *Cardium*, and of some other lamellibranchs in which the palp folds are large, to see what he can find. Let him be warned that he has no simple task, to be decided by a few observations. The turmoil on the palp face is so extraordinarily confusing that it seems just possible that even Engelmann may have been mistaken. I have supposed that I also have seen a reversal of the cilia beat on the palp, but many years ago concluded that I was mistaken. It is entirely possible that my present belief is erroneous, but I would prefer to be corrected by some one who has at least made an effort to study a few lamellibranchs, instead of studying papers. That protozoa reverse the cilia beat adaptively in food selection is suggestive in this case; but protozoa are not lamellibranchs, and I had hoped that the argument from analogy had been aban-

doned by biologists, especially in cases in which there was no possible excuse for it.

Professor Grave has fortified himself against confirmation of my views by assuming the position that even if no reversal of the beat of cilia is to be observed when my methods are employed, "it seems clear that it was due to the fact that the animals on which he made his observations were, in every case, in a mutilated condition." I removed the shell, "and," he says, "in its removal the adductor muscle was cut and the visceral ganglion, which is imbedded in this muscle, was necessarily severely injured. Under such a condition of shock normal behavior is not to be expected, especially in the case of activities that may be subject to nervous control."

Here is another pure assumption, made without observation, or even the opinion of some one else to substantiate it. I have no reason to believe that there is any element of truth in it; and I have several reasons for believing that it is not true that cilia of the palp, gill or mantle tracts are in any way under the control of the nervous system (such as the continued and unchanged beat on fragments of any of these organs, and also on isolated single cells, facts that can not be presented here).

Now the action of gill and mantle cilia are precisely the same in normal and in "mutilated" *Pectens*, and in some other lamellibranchs that open the shell valves widely, a condition that I have observed very many times. Why should Professor Grave not naturally expect these cilia tracts, as well as those of the palps, to behave abnormally from the detachment of the end of the adductor muscle? For he must know that gills and mantle receive large nerve trunks from the visceral ganglion, while the palps do not. The palps are so situated that they can not be examined without removing the shell valve, or using great force to pry the valves far apart by stretching the adductor muscles, and I have not seen their currents otherwise. I would like to ask Professor Grave if Engelmann was careful not to mutilate the lamellibranch on the palp of which he discovered a reversal of the cilia beat?

Finally, the cause of my mistakes in observation, we are told, was that when the end of the adductor muscle was separated from its shell attachment, the visceral ganglion "was necessarily injured." I venture to offer the information that, when one actually tries the experiment, it will be found that a shell valve may quite easily be removed from any lamellibranch without touching the visceral ganglion, or any of the nerves arising from it; and that to say that it is necessarily injured in the process is but to add another to the list of these entirely unsupported assumptions. This *a priori* method of arriving at truth ought to be even more out of place in present-day biology than the employment of analogies. Very likely, the use of the binocular dissecting microscope, which I did not have because it was not yet invented, will show that I made mistakes; but years were spent in making the observations before they were published, and perhaps I may be pardoned for objecting to their summary dismissal, in some cases with a very small show of reason, and in others with none at all.

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CHLOROSIS OF PINEAPPLES INDUCED BY MANGANESE AND CARBONATE OF LIME

It has been recently found by M. O. Johnson at the Hawaiian Experiment Station that the chlorosis of pineapples occurring on highly manganiferous soils can be cured by spraying the leaves with ferrous sulphate.[1] As the chlorosis of pineapples growing on strongly calcareous soils in Porto Rico can also be cured by the application of iron salts, some have the idea that the two forms of chlorosis are the same. Although the phenomena are remarkably similar in many respects, and although the cure is the same, it is not yet clear that they are identical. It seems advisable to point out certain differences that seem to exist in the two kinds of chlorosis.

[1] *The Pacific Commercial Advertiser*, Honolulu, Hawaii, July 21, 1916, and a personal communication.

The chlorotic pineapples in Hawaii occur on acid or neutral soils that average 5.0 per cent. Mn_3O_4 and 0.5 per cent. CaO.[2] The chlorotic pineapples in Porto Rico occur on soils containing from 2 to 80 per cent. carbonate of lime and no manganese. That the chlorosis in Porto Rico is induced by the carbonate of lime was proved by direct experiment. Soils which normally produced healthy pineapples were made to produce chlorotic plants by the admixture of carbonate of lime from different sources.[3] We may thus speak of one as a manganese-induced chlorosis and the other as a lime-induced chlorosis.

The lime chlorosis was shown to be due to a lack of iron in the plant, caused by the carbonate of lime diminishing the availability of iron in the soil. At first it was not known whether the chlorosis was due merely to a lack of iron or to a lack of iron combined with a large amount of lime in the plant. Recent work seems to show that it is merely due to a lack of iron.

Now the manganese chlorosis may be similar to the lime chlorosis if the manganese acts similarly in merely diminishing the availability of iron in the soil. The recent discovery of Johnson shows that this may be possible. Previous work by Kelley,[4] and Wilcox and Kelley[5] suggests, however, that the manganese chlorosis may be more complicated. In the work of these investigators there is some evidence of a direct toxic effect of the manganese, although they do not ascribe the chlorosis to this. It is possible that the manganese chlorosis is due to a deficiency of iron combined with a direct toxic effect of the manganese. From the results so far obtained it can not be said whether the two kinds of chlorosis are essentially the same. Certain differences in the appearance and behavior of pineapples affected with manganese and lime chlorosis give reason for supposing the two forms may be more or less distinct.

The manganese plants are described as having roots with swollen tips and a generally poor root system, while the lime plants have good root systems, differing from normal plants only in the roots being longer.

In the development of "manganese yellows" a purplish color is spoken of as preceding the yellowish-white. This purplish color was not observed in the lime-induced chlorosis, although leaves sometimes had red splotches.

The manganese chlorosis is described as being most intense during the winter months when we may assume normal plants were growing less rapidly. The lime-induced chlorosis we found to develop fastest in plants growing most rapidly and to be more intense the more sunlight they received.

The application of ferrous sulphate to the leaves apparently has a more permanent effect on the manganese plants than on the lime plants. From the reports so far it appears that a few sprayings permanently cure the "manganese yellows," while application of iron salts to pineapples, rice, or sugar cane affected with lime-induced chlorosis effects only a temporary cure. Repeated trials showed that the treatment must be made frequently to maintain the plants in a green and vigorous condition. With rice growing on a strongly calcareous soil it was necessary to spray sixteen times with ferrous sulphate to maintain a normal growth. This difference in the amount of treatment necessary to cure the two forms of chlorosis may merely indicate a difference in the extent to which manganese and carbonate of lime depress the availability of iron.

The differences pointed out lend ground for supposing that manganese chlorosis may be due in part to a deficiency of iron in the plant, induced by the action of manganese in the plant or in the soil, and in part to a direct toxic action of the manganese. Lime-induced merely the result of a lack of iron in the plant, due to carbonate of lime diminishing the availability of iron in the soil. It is of

[2] Kelley, W. P., Hawaii Agr. Exp. Sta. Press Bull. No. 23.

[3] Gile, P. L., Porto Rico Agr. Exp. Sta. Bull. No. 11, 1911.

[4] Kelley, W. P., Hawaii Agr. Exp. Sta. Bull. No. 26, 1912.

[5] Wilcox, E. V., and Kelley, W. P., Hawaii Agr. Exp. Sta. Bull. No. 28, 1912.

course possible that the two kinds of chlorosis may be found to be essentially the same except for certain secondary effects produced by an undue absorption of manganese.

P. L. Gile

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RELATIVE IMPORTANCE OF FUNGI AND BACTERIA IN SOIL

To the Editor of Science: In a recent number of Science,[1] Waksman discusses the question: "Do Fungi Live and Produce Mycelium in Soil?" He answers the question in the affirmative. I have been interested in the same question for some time and have arrived at conclusions slightly different from those to be inferred from Waksman's article.

Waksman has tested for the presence of mycelium by placing a lump of soil about 1 cm. in diameter in the center of a plate of agar (containing Czapek's solution[2] for nutrient material). After 24 hours at 20–22° C., he finds that mold hyphæ radiate out into the medium from this lump of soil. If instead of soil he uses a drop of water in which mold spores are suspended, the amount of mycelium produced in 24 hours is very much smaller. From these findings he concludes that such a lump of soil contains living mycelium.

This conclusion is undoubtedly supported by theoretical considerations. The soil is continually showered with mold conidia from the air and without question contains moisture enough to allow them to germinate even if conditions are not favorable for their long-continued growth. The presence of mushrooms, moreover, in woodland soil and even in fields and lawns, proves beyond doubt that conditions do favor the growth of certain Basidiomycetes, at least. Their mycelium undoubtedly penetrates the soil sufficiently to be present in a lump as large as that used by Waksman. The question of real importance, however, is whether the mycelium is abundant enough in the soil to compare in its activities with the soil bacteria. Waksman does not discuss this question; although from his statement that the plate method gives figures as high as 1,000,000 fungi per gram soil, the natural implication is that they must be nearly as important as bacteria. His actual data, however, show nothing of the sort. He merely shows that mold hyphæ can be found in lumps of soil 1 cm. in diameter. A lump of soil that size contains many millions of bacteria. Compared to their activities, those of a few mold hyphæ would be quite insignificant.

I have tested several soils by Waksman's method, and have generally obtained results similar to his; but because the information furnished by it is not quantitative, I have modified the method by the use of smaller quantities of soil (crumbs weighing about 10 mg.), with quite different results. Such a crumb of soil should contain, according to the plate method—which is generally acknowledged to give figures that are much too low—perhaps 100,000 bacteria. If fungi are of anything like the same importance as bacteria in soil, one of these crumbs should certainly contain mold hyphæ. Their presence, however, has been indicated only in the case of soil to which large amounts of organic matter (manure or grass roots) have been added. When crumbs of soil to which no organic matter has been added have been used, the development of mold hyphæ in the agar has been slower than in the case of drops of water containing nothing but mold conidia. This certainly suggests that no mycelium is present in these small crumbs and that molds are relatively insignificant in soil; but as the crumbs of soil were always surrounded at the end of 24 hours by vigorously growing bacteria, it is possible that the development of mold hyphæ may have been suppressed. For this reason, Waksman's method is considered inconclusive.

It seems as if the question could be conclusively answered only by the use of a microscope. The microscope would furnish direct instead of presumptive evidence on the sub-

[1] Science, N. S., 44, pp. 320–322.

[2] Waksman does not publish the formula of this solution, but it has been obtained from him in a personal letter. It is: $MgSO_4$ 0.5 g., K_2HPO_4 1 g., KCl 0.5 g., $FeSO_4$ 0.01 g., $NaNO_3$ 2 g., Sucrose 30 g., to one liter of water.

ject. The reason no one has ever used a microscope in answering this and similar questions is undoubtedly because it is difficult to distinguish soil microorganisms without staining, and hard to stain them without staining the dead organic matter of the soil so deeply as to obscure the microorganisms. I have been struggling with these difficulties for the last two years and have at last found a method of staining that shows up the microorganisms of the soil without staining the soil particles or the dead organic matter. The details of the method are not yet ready for publication, but will be in a couple of months. Even though the technic is not yet perfected, it has furnished information that helps answer the question discussed by Waksman.

Briefly stated, every kind of soil microorganism except mold hyphæ has been revealed. Bacteria are shown in large numbers. So are Actinomyces conidia; while masses of Actinomyces hyphæ have been observed. Algæ are not uncommon, and objects resembling mold conidia have been found. Some organisms have been observed that are strongly suggestive of protozoa. But of mold hyphæ only an occasional small fragment has been seen, even in soil rich in organic matter. I realize that this microscopic method may, for some unknown reason, fail to reveal mold hyphæ even when they are present; but it is at least a direct method, while Waksman's method is indirect.

Although Waksman was presumably correct in his statement that fungus mycelium is present in soil, it is doubtful whether it exists there to a significant extent. Of course fungi live in soil, particularly when large amounts of organic matter are present; but it is hardly fair to compare their activities with those of bacteria—as has often been done in the past, either directly or by implication—until it is shown that their mycelium is present in soil in sufficient quantities to compare with the large numbers of bacteria that are known to be present in active form.

H. Joel Conn

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THE SUDDEN APPEARANCE OF GREAT NUMBERS OF FRESH-WATER MEDUSÆ IN A KENTUCKY CREEK

On the morning of September 27, 1916, there was brought to me a large bottle of creek water in which were the badly decomposed remains of several small gelatinous bodies which to my great surprise were recognized as parts of medusæ. They proved to have come from Benson Creek near Frankfort, about twenty-eight miles from Lexington, and had been alive, it was reported, the preceding evening. The bottle of water containing them had been brought to Lexington by Mr. Ben Marshall of the revenue service, at whose Frankfort office it had been left by Mr. C. M. Bridgemord. The latter was said to have asserted that he saw "millions" of the animals in the water. There was reason for some doubt about the "millions," but the evidence of the decomposed bodies showed that there were some in the creek and I could not rest satisfied without examining the locality for myself. With Mr. Marshall I left Lexington in the afternoon and arrived at his office in Frankfort about 4 o'clock P.M., where we found Mr. Bridgemord and Mr. J. L. Cox of the office, who is an ardent angler and had become interested in the animals. These gentlemen very kindly took me in a motor-boat down Kentucky River, and a short distance below the L. & N. R. R. bridge we turned into the mouth of Benson Creek and proceeded up the stream. Kentucky River has been dammed below this point, so that the water is backed into the lower park of the creek, producing a rather narrow, deep body of water with but little current. We traveled up this backwater for about a half mile, when we reached the point where the medusæ had been captured. The water looked rather bad and unsuited to them at first, but became better farther up, though still not very clear and with its surface roughened by a slight wind. The water was quite warm.

As soon as we reached the part of the stream where the medusæ had been found we began to strain our eyes, attempting to get a glimpse of one in the murky water. Very soon one was seen, a floating, pulsating gray

object, a few inches below the surface, looking so much like a bit of rubbish that it would certainly not have been recognized had we not been looking for it. Then several were seen near each other, then a few scattered individuals, which were all carefully taken into bottles, or with a small collecting net. Finally in the center of the stream we encountered them in numbers and from that time until it began to get too dark to see well, the boat was generally surrounded by them. There were four people in the boat filling bottles and jars rapidly and in a few minutes we gathered some scores. Often with a single movement of the net I captured several and before taking it in had secured a half dozen or more. Dozens were in sight at one time, and it was soon evident that Mr. Bridgemord was right, and that in truth there were millions of these medusæ in the stream. I have worked on the aquatic animals of Kentucky waters for many years and was not prepared to believe that medusæ would ever be found within the state in such numbers, nor indeed in any fresh water of the United States. Several hundred living individuals were brought back to Lexington with me, and some of them were alive until the afternoon of September 28. One by one they died in our city water, though it was kept running slowly through the aquarium in which they were confined. The temperature may have been too low or the water otherwise unsuited to them. A good many were fixed with corrosive sublimate and preserved, so it may be possible to study them fully and determine something of their relationships.

Like others of their kind they are hyalin, excepting the flap-like yellow reproductive bodies attached to the four radial canals close to the stomach. The umbrella-shaped body is widely convex, the depth (in life) being perhaps one third the diameter. It measures from about 14 to 15 millimeters across. The manubrium is prismatic and extends downward to the level of the outer margin of the umbrella; the mouth is surrounded by an eight-lobed rosette. At the margin of the umbrella are four long tentacles (perradial), measuring about 14 millimeters, which are attached a short distance above the margin, and in life are disposed to extend upward. Secondary more slender tentacles are about half the length of these large ones and are also attached above the margin; then still nearer the margin are numerous minute tentacles thickly crowded at their bases.

Where this multitude of medusæ came from is a mystery. Mr. Bridgemord, who first saw them, has fished in the stream for a good many years, but never saw one until September 26. I myself have several times examined the upper part of the creek rather carefully in search of *Simulium* larvæ, and while Polyzoa (a *Plumatella*) were abundant on the rocks, nothing resembling a hydroid was present in the water. My examinations were made some years ago, however. The hydroid generation in the stream ought to be easily discovered if the myriads of medusæ are any indication as to its abundance. I have not yet had an opportunity to search for this stage, but expect to do so at once.

Of the three genera to which fresh-water medusæ have been assigned, the Kentucky species belongs unquestionably to *Craspedacusta*. Dr. Mayer[1] describes *C. sowerbyi*, first discovered in a lily tank in Regent's Park, London, and later found in other parts of the world, as 12 millimeters wide. The Kentucky examples are somewhat wider, but in other respects agree closely with Dr. Mayer's description, excepting in the length of the manubrium, which he says extends half its length beyond the velar opening, whereas in Kentucky examples it reaches to about the level of the bell margin. In this respect the latter agree with the *C. kawaii*, described by Oka[2] from the Yang-tse-kiang River, China, but differ again and agree with *C. sowerbyi* in having but three ranks of marginal tentacles instead of seven. Dr. Mayer[3] thinks the Chinese species may be an exceptionally flourishing form of *C. sowerbyi*. The Kentucky examples are still nearer the medusæ described from Regent's Park. *Thaumantias lacustris* from a fresh-water lagoon in Trinidad is very

1 "Medusæ of the World," 1910.

2 "Annotationes Zoologicæ," Vol. 6, 1907.

3 *Loc. cit.*

different, being only from 2 to 2.5 mm. in diameter, the bell provided with 16 to 24 long tentacles with basal bulbs. The American *Microhydra ryderi*[4] is only 0.4 mm. in diameter. It may be the young medusa of *Craspedacusta,* but shows some differences from young *C. sowerbyi. Limnocida tanganyicæ* Gunther, from Lake Tanganyika, Central Africa, has the gonads attached to the stomach, and differs otherwise.

Everything considered, it seems best for the present to regard the Kentucky medusæ as a form of *C. sowerbyi.*

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SCIENTIFIC BOOKS

With Scott: The Silver Lining. By GRIFFITH TAYLOR, D.Sc. With nearly 200 illustrations and maps. New York: Dodd, Mead and Co. Pp. xiv + 454. $5.00 net.

Few volumes on polar exploration have been written so attractively as to the phases treated. The author has placed the reader in possession of the environment, wherein his own experiences are largely subordinated to the story, both of the incidents of antarctic research and also to the aspects of polar nature and its scanty fauna. The style is delightfully human, and is often brightened by humor. Indeed it admirably presents the silver lining of Scott's tragic expedition.

The biologist, the geologist and other scientists will find much information along lines usually ignored by polar authors, who are inclined to adhere closely to their specialties, and in technical fashion. These data are most welcome as the detailed memoirs, on the very extensive and most varied scientific researches of Scott's expedition, will not be completed for several years, though ample funds have been provided for their publication.

Botanists will be interested in the discovery of considerable patches of moss, on the east coast of Victoria Land, on which all the field work of Taylor was done—in two journeys. Taylor says:

[4] Potts, SCIENCE, Vol. 5, 1885.

I was amazed to see a carpet of green moss, as flourishing as any in more temperate regions—three types of vegetation were present. One was the moss, to my unbotanical eyes, of universal distribution. The other two species may have been algæ, one resembled the sea-weed called *Ulva.* The patch of green was 60 feet long and about 15 wide —possibly the largest area of vegetation south of 77°.5.

Sea-kale planted in the open air sprouted but did not develop.

Insects were found, the antarctic *springtail,* of which the record says. They were found

clustering among the whitish roots or hyphæ of the moss. They would be frozen stiff in a thin film of ice until one turned the stone into the sun. Then the ice would melt and they would move sluggishly about until the sun left them. I can not imagine a finer example of hibernation.

There were two species, one red and the other the millimeter-long blue, both unknown.

Of the antarctic sea—noted on the voyages to and fro—the author writes:

Microscopic life simply swarms in these polar seas, to an infinitely greater extent than in the warmer waters of the tropics, though one would be inclined to the opposite belief. . . . There is almost as much protoplasm per acre of ocean as there is in a well-cultivated crop on land. The description of the cycle of life is interesting, to a layman at least—from plankton to whale-killers.

Meteorologists will find data as to blizzards, etc., which are much less violent on the shores of Ross Sea than those reported by Mawson from Adelie Land. The record with Scott was that of July 12, 1911, when the maximum wind was 70 miles per hour, with a maximum temperature of 8°. The comparative mean temperatures for the years 1902–03 and 1911, were respectively as follows: (approximately) January, 24° and 22°; February, 13° and 15°; March, 4° and 8°; April, — 8° and — 2°; May, — 14° and — 12°; June, — 15° and — 14°; July, — 16° and — 22°; August, — 17° and — 23°; September, — 15° and — 17°; October, — 7° and — 2°; November, 13° and 13°; December, —23° and — 21°. The minimum temperature mentioned is that of — 77° experienced by Cherry in his visit to

Cape Crozier for the purpose of obtaining eggs of the emperor penguin.

Naturally the most extensive data pertain to geological subjects relative to west Victoria Land, which was twice visited and explored by Taylor, under conditions of extreme hardship which tested the strength and endurance of the party to the utmost. Taylor's line of research specially pertained to the "effect of ice in carving out the features of the earth's surface." Near two great glaciers he noted:

> The grandest geological section I have ever seen. It was capped by yellowish rock, which represents the most eastern exposure of the Beacon sandstone in the valley. Beneath this were two *sills* of dolorite . . . which represented flows of lava wedged in between the granites and sandstones. . . . Above and below the lower of these black sills were layers of gray granite.

Considerable attention is given to descriptions of cwm, or arm-chair, valleys. At one point was discovered a huge deposit of mirabilite (sodium sulphate) about 10 by 50 feet in surface area.

The seaward movement of the antarctic glaciers engaged Taylor's attention, and careful measurements were made of several. During the ten coldest months one moved about twenty feet. The Tongue on the east coast of Victoria Land was moving seaward about a yard a day in January—midsummer.

The vitally important fossils of the expedition are those obtained by Scott at the head of Beardmore glacier—in my opinion elsewhere expressed, obtained and preserved at the cost of the lives of that heroic explorer and his sledge comrades—which are considered as epoch-making in antarctic geological history. Among these, it may be recalled, was a fern-like *Glossopteris,* a plant of the Permo-Carboniferous age. Other fossils of the Cambrian age had been brought back by Shackleton from the Beardmore glacier, in 84° S., among which were specimens of one fossil which united the character of the sponges and corals.

Taylor's party—Debenham, Gran and Taylor—contributed specimens of fossils of the armor-plate of a primitive fish. They are thought to pertain to the Devonian age, and so are intermediate between the antarctic fossils of the Cambrian limestones and the Permian coal-measures.

One must read the book itself to obtain any adequate idea of the hardships and privations endured by Taylor, Debenham and Gran in their geological researches on Victoria Land. They were accepted as part of the *game,* and with such a spirit of comradeship and solidarity as alleviated the inevitable miseries of field life in the polar regions. This fine spirit is indirectly exhibited by Taylor at the end of his story, where he says:

> Only in polar lands is to be found the joy of a *real return to the primitive,* in association with the best types of strenuous youth. There, if anywhere, is life worth while.

A. W. Greely

Rhynchophora or Weevils of Northeastern America. By W. S. Blatchley and C. W. Leng. The Nature Publishing Co., Indianapolis. Pp. 682. Price $4.00.

When, in 1910, the senior author, Mr. Blatchley, published his notable work on the Coleoptera of Indiana, the Rhynchophora were not included. We had, however, the assurance of the author that a further paper covering this group would be forthcoming. In the appearance of the present volume, the promise of six years ago is more than fulfilled, for we have here not merely a complement to the Coleoptera of Indiana, but a review of much wider usefulness, covering as it does the entire country east of the Mississippi River.

Although the Rhynchophora or Weevils—the latter term used in the entomological rather than in the popular sense—constitutes only about twelve or fifteen per cent. of the Coleopterous fauna of the country, still the number of species is very large—no less than 1,084 being recognized by the authors from the territory named, these being distributed among nearly 300 genera. The only previous work on North American Rhynchophora with which the present one can be compared is that published by Le Conte and Horn in 1876. This Coleopterological classic, although still of the greatest value as the basis of our modern classification, is altogether inadequate as a student's handbook, the number of species

given from the whole United States being less than two thirds of that now known from east of the Mississippi.

As expressed by the authors, the primary object of the present manual is—as in the "Beetles of Indiana"—"to furnish to students and tyros in entomology a simple means of enabling them in the most direct way possible to arrange, classify and determine the scientific names of the weevils in their collections." To do this, all the higher subdivisions have been carefully defined, keys for the separation of all families, tribes, genera and species have been prepared or adapted, original descriptions have been condensed so as to show more readily the principal diagnostic characters, and geographical range, time of appearance and habits recorded so far as known. The whole is preceded by a chapter on structural characters, and followed by a tolerably complete bibliography and indexes of both the beetles and the plants on which they occur. Add to this the fact that the press work leaves little to be desired and the illustrations are numerous, nearly all good, and many of them beautiful, and we have a very attractive as well as useful contribution to Coleopterology.

In a work of this sort, based upon a multiplicity of sources of information, it is inevitable that there should be some errors of fact; furthermore inasmuch as all schemes of classification and taxonomy involve so large an element of individual opinion, it is altogether unlikely that any specialist could be found who would agree entirely with the authors in their sequence of tribes, genera, etc., or in their delimitation of species. The authors, on the whole, appear to have followed a sanely conservative course, and, while the work embodies the results of the best of recent studies both in this country and in Europe, they have rarely accepted the views of the extremists, and, where differing from the authorities, have frankly stated the reasons for their conclusions.

Let no one be deceived by the words of the authors, quoted above, into believing that the book will prove a sinecure for the entomological "tyro." A difficult subject has perhaps been simplified as far as possible, but it still remains a difficult subject, and the tyro will still have to depend largely on the specialist for the determination of his specimens. On the other hand, the student with a considerable fund of experience will find this work of very great assistance. Would that we had more like it.

H. C. Fall

Pasadena, Calif.

SCIENTIFIC JOURNALS AND ARTICLES

Bollettino di Bibliografia e Storia delle Scienze Matematiche. Publicato per cura di Gino Loria. Torino, 1915, 1916.

Such are the conditions in Europe at the present time that both the publication and the transmission of scientific journals are attended with great difficulty. Some of these journals have been discontinued altogether, others appear in reduced form, and many are greatly delayed if, indeed, they are allowed to pass the barriers at all. Of those which reach us Professor Loria's "Bollettino" is among the most regular and among those which best preserve their usual placidity.

Since this publication consists chiefly of notes on recent mathematical works, there are but few articles that admit of interesting summary in a review of this nature. It is pleasant to observe, however, how little the war disturbs the academic atmosphere, for these mathematical notes, relating to current books of various European belligerents, give no evidence whatever of the conflict which now disturbs the world. Such, for example, are the "notizie" on "La matematica in Germania in questo ultimo quarto di secolo," "Sofia Germain" (by Schwarz), the "Materialien für eine wissenschaftliche Biographie von Gauss" (Klein and Brendel), and the "Entwickelung der Mengenlehre und ihrer Anwendungen" (Schoenfliess).

Of the original articles of a mathematico-historical nature, mention should be made of a few which may have some interest to American readers. M. Lucien Godeaux of Liège has an article on "Un mathématicien Belge du XVIième Siècle: Jean Taisnier." Al-

though Quételet mentions this writer in his "Histoire des sciences mathématiques et physiques chez les Belges," and Jules Dewert and Modeste Soons have recently written upon his work, he is practically unknown to English and American mathematicians. Born in 1508, dying probably about 1562, he claims to have been a professor of mathematics in Rome in 1546, and he certainly held such a chair in Ferrara in 1548. His works, eleven in number, relate chiefly to the use of the sphere and the annulus, although some were purely astrological in their contents. One of his books was translated into English under the title "A Booke concerning navigation, translated into English by Richard Eden," London, n.d. Like most of the secondary writers of his time, he plagiarized freely from the works of others, but his "De annuli sphaerici fabrica & usu" (Palermo, 1550) shows not a little originality.

Professor J. H. Graf, of Berne, whose contributions to the history of mathematics in Switzerland are well known, has a series of articles on "La correspondence entre Ludwig Schläfli et des methématiciens Italiens de son epoque." This is a suitable sequence to Professor Graf's earlier articles on the correspondence between Schläfli and Jakob Steiner and between Schläfli and Cayley.

Professor G. Vivanti has an interesting note on Luigi Forni, a Pavian mathematician (1780–1856), whose Nuove Ricerche (Pavia, 1811) is not without merit. There are biographical articles of some length on Luciano Orlando (1877–1915), a prolific writer, and Ruggiero Torelli (1884–1915), a worthy contributor to modern higher algebra and the theory of curves. The numerous reviews by Professor Loria himself are of special interest.

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"THE AMERICAN MINERALOGIST"

The American Mineralogist is a new magazine, devoted to the interests of the scientific mineralogist, the student of mineralogy, curators of museums, and collectors of minerals.

It is a successor to *The Mineral Collector*, founded in 1885 and discontinued in 1909; and appropriately, the first article in the new magazine consists of an appreciation of the contributions of Arthur Chamberlain, publisher of *The Mineral Collector*. Other articles in the first number treat of lamellar calcite, columnar manganocalcite, the chemical elements; and the reports of the meetings of the New York and Philadelphia Mineralogical Clubs are given. The magazine reviews abstract articles on mineralogical subjects, so as to make the work being done in this science available to those who do not have access to the more technical journals.

The second number is devoted to an account of the wonderful gem minerals of Madagascar. In the third number is an article on glauberite crystal-cavities, in which the methods used in interpreting these curious "holes" in certain geological formations are described. Stevensite, an alteration product of pectolite from New Jersey, is shown to deserve recognition as a definite mineral species by Mr. M. L. Glenn. A poem, called "The Physico-chemical View," a satire on the mannerisms of several Washington scientists, is included.

The Exchange Column of *The American Mineralogist* is an excellent feature and one that will interest every private collector or curator of a museum who may wish to dispose of his duplicate material for some specimens in which his collection is lacking. Thus both parties are benefited, and the various mineralogical dealers will keep those informed who are in need of such materials.

The American Mineralogist is edited by Wallace Goold Levison, and the associate editors are Edgar T. Wherry, of the U. S. National Museum; Samuel G. Gordon, of the Academy of Natural Sciences, Philadelphia, Pa., and W. Scott Lewis, of the Krotona Institute, Los Angeles, California. The magazine is octavo in size, and the numbers already issued have given sufficient assurance that the typography will continue to be excellent. As this special field has never before been covered, the journal should meet with considerable encouragement and success.

G. F. K.

NITRATE DEPOSITS IN THE UNITED STATES

A press bulletin of the U. S. Geological Survey states that nitrate deposits in many parts of the United States have been examined during the last two years by the survey. The importance of finding a natural supply of nitrates within our own borders has given incentive to this work and has directed widespread public attention to the subject.

Prospectors in many places have raised great hopes by finding good surface showings of these salts, but investigation has seemed to force the acceptance of a general adverse judgment as to their value—a judgment that has been adopted with the greatest reluctance by all concerned. Incidentally, advantage seems to have been taken of the situation to promote certain stock-selling enterprises, even after the evidence as to the worthlessness of the deposits became sufficient to satisfy any competent judge, so that one is forced to question either the good faith of the promoters or their practical judgment.

As a result of careful study of these deposits, and particularly of evidence gathered on recent visits to prospects in different parts of the country, Mr. Hoyt S. Gale, a geologist of the Federal Survey, has submitted the following general summary, which is commended to the consideration of those who are tempted to invest their money in such enterprises.

Fine specimens of practically pure nitrate of soda and nitrate of potash (saltpeter) have been found in many parts of the country, and careful investigation of specimens and localities seems to warrant some definite conclusions as to the practical value of these deposits, especially to those who are invited to spend their money in investigations like those the survey has already made.

The nitrate salts occur as crusts or films on the faces of ledges; as seams—most of them thin, though some are fairly thick—in crevices of shattered rock; and as deposits filling spaces in porous rocks at and near the surface or extending to a depth of several feet. They are naturally preserved in recesses in the rock ledges, where they are sheltered from the dissolving action of rain, snow water, or even mist. They are found in lava ledges, in beds of volcanic tuff or ash, and in limestone and sandstone. Their existence or preservation is apparently dependent rather on the shattered or porous nature of the rock than on its kind or composition. These deposits, which have been referred to as cave or ledge deposits, are of essentially the same type wherever found, although they vary considerably in details of occurrence.

The incrustations are found not only on the faces and fractures of ledges of solid rock, but some of them form layers or cementing constituents in the loose soil and rock breccia at the bases of cliffs, or lie in places protected from the weather. Some samples obtained from both these sources are rich in nitrate salts, and analyses of such materials will bear little significant relation to the actual character or content of the mass of the rock of which the ledge is formed. It appears that the deposits are surficial—that is, they do not extend far into the mass of the rock—and the nitrate salt found is insignificant in amount.

Nitrates are found in unusually large quantities in some soils and in some clay hills, particularly in southern California. These deposits have been examined by many persons and the general conclusion reached has been unfavorable to the idea of their practical utilization. The nitrate content, although unusually large as compared with the content of ordinary soils, probably does not average over 1 or 2 per cent. of the soil or clay, and it is very doubtful whether the material could be worked commercially.

Any one who is not convinced by the judgment already reached as to these deposits and who is determined to devote his time or money to their further exploration should do so with full knowledge of the evidence already in hand and should not be led into such a venture by more or less misleading representations. The Geological Survey will always be glad to make an examination of any samples submitted.

AGRICULTURE OF THE HIDATSA INDIANS

A doctor's thesis of unusual practical value is that of Dr. Gilbert L. Wilson submitted in

June to the faculty of the University of Minnesota for the degree of Ph.D. in anthropology.

With funds largely from the American Museum of Natural History, New York, research work has been prosecuted each summer since 1910 among the Hidatsa and Mandan Indians on the Mandan Reservation, North Dakota. So important have the findings of Mr. Wilson been for probable development of a drought-resistant maize for the farmers of the northwest that both Dean A. F. Woods, of the college of agriculture, University of Minnesota, and Mr. M. L. Wilson, of the Agriculture Experiment Station, Bozeman, Montana, have contributed toward the financial support of the research.

It is interesting to learn that in western North Dakota where maize has been a doubtful crop as grown by the white farmer, the Hidatsa and Mandan Indians have for centuries been successfully cultivating it. With crudest wooden and bone tools they developed an agriculture that in some respects surpassed that of most white farmers at present in that area.

Maize, sunflowers, beans, squashes and tobacco were raised by the Hidatsas, but their principal crop was maize. The chief varieties of maize were white and yellow flint, "sweet corn," and those producing white and yellow meal. Corn planting began when the wild gooseberry came to full leaf. The corn hills were prepared with digging-stick and bone-bladed hoe. The earth was raked over the seed and patted down with the hands. Each corn hill stood exactly where a hill had stood the year before. The fields were hoed twice during the summer. The second hoeing was accompanied by hilling up.

Corn was husked in the field. Friends and relatives commonly joined in a husking bee. Fine full ears were braided in strings; and from these strings, carefully dried, seed ears were chosen for the next year. A provident family kept two years' seed on hand, in order that the ill-favored grain of a poor year might not have to be sown. In the selection and preparation of seeds of all their cultivated crops, these Hidatsa Indians were far more careful than most of our American farmers. The braided strings of ears were transported from the field to the village on the backs of ponies. Smaller loose ears were borne in baskets on the backs of the women; these smaller ears made the main part of the harvest. Before each lodge stood a drying stage, a rather elaborate structure floored with planks split from cottonwood trees. On this floor the loose ears were spread to dry. The braided strings were hung on a railing above, and were bound closely in small bunches to prevent the wind from shelling the drying grain. When well dried the smaller ears were threshed or shelled, and this threshed grain and the braided ears were stored and sealed in jug-shaped caches or pits dug in the ground. Green corn, after having been boiled, shelled and dried, was stored in the caches in bags. Curiously, sweet corn, or "gummy corn" as the Indians call it, was never boiled green. It was prepared by parching, after having become thoroughly ripe.

Fallowing of fields was practised by the Hidatsa agriculturists, and they knew that wood ashes increased the yield of a field. When new ground was cleared the felled trees and bushes were spread over the field and burned for the sake of the ash.

While most of the field work was done by the women, the men assisted in part of the labors. They aided in clearing the fields, and did the heavy lifting when a stage was built. However, it was thought that a younger man was better employed hunting, or warring. But when the men's hunting and war days were over they thought it no shame to help their women plant and hoe. Field work was done in the early hours of the day, the women commonly rising with the sun, and returning to the village to eat and rest about ten o'clock in the forenoon.

Seed corn from the most intelligent and skilled of the Hidatsa women is being sold to northwest farmers by a commercial seed house. This fact and the breeding experiments by scientific experimenters bid fair to make another contribution to American economic life by the Indian.

The thesis is being printed by the University of Minnesota.

ALBERT ERNEST JENKS

SPECIAL ARTICLES

THE CHEMICAL CONSTITUTION OF CHITIN[1]

THE prevalent ideas concerning the molecular structure of chitin have been based upon the fact that it gives off acetic acid when acted upon by strong reagents, such as concentrated acid or alkali, and that its elementary composition suggests the empirical formula $C_8H_{15}NO_6$.[2] Since it is also known that chitin yields on decomposition glucosamin it was a logical inference that the above formula represents an acetylated glucosamin

$$\begin{array}{l} CH_2OH \\ CHOH_3 \\ CH—NH—CH_3CO \\ CHO \end{array}$$

of which chitin is the polymere.

This hypothesis regarding the structure of chitin has been strengthened by other observations, viz., that if chitin is dissolved in strong sulphuric acid, allowed to stand several days and then diluted with a large quantity of water, a white precipitate is formed which on analysis proves to be a monoacetylglucosamin. Occasionally, however, a substance is isolated which represents a monoacetyldiglucosamin.

An investigation upon chitin of lobsters which I conducted recently at the Woods Hole Fisheries Biological Laboratory brought out certain facts which indicate that, while the observations and analyses mentioned previously are doubtless correct, the hypothesis to which they gave origin is based largely upon misconception. I shall present here a brief outline of the principal results of the investigation, reserving a more detailed statement for publication in the near future.

It will not be necessary in this preliminary note to discuss the experimental procedure beyond the mere statement that pure chitin was hydrolyzed with varying strengths of sulphuric acid, and for varying lengths of time, the cleavage products as well as the volatile substances formed during hydrolysis having been quantitatively determined.

The results of fundamental significance yielded by this investigation are the following:

First. Very little volatile acid is formed in the early period of hydrolysis of chitin, though all its glucose molecules may already be split off. A very large production of volatile acid is invariably found when the sugar molecule itself is attacked by the acid medium.

Second. The volatile acid produced is not acetic only. At least in one experiment it was possible to show that two per cent. of the acid was formic. There is good reason for believing that other volatile acids, too, may be formed, but the attempt at isolating and identifying those has not yet succeeded.

Third. The maximum yield of sugar is about 81 per cent.

Fourth. The amino group is readily split off from the glucosamine. The hydrolyzed material contains the ammonium sulphate which can be distilled off directly by making it alkaline, and the ammonia can be collected in standard acid.

Fifth. The nitrogen of the amino group ***does not represent the total nitrogen in the chitin molecule.*** There is another nitrogenous part in the molecule which is characterized by great resistance, so that the nitrogen of that small fraction can be obtained only by digesting with concentrated sulphuric acid. There is a remarkably constant relation between this easily detachable nitrogen group and the stabile nitrogen fraction. In my experiments, the latter formed 12.04 to 12.45 per cent. of the total nitrogen.

The interpretation of these results is very obvious. The chitin molecule is certainly more complex than previously assumed. It may be regarded as consisting of two parts: one containing all the glucose and all the amino groups, the other being a stable nitrogenous compound which yields no glucose. It would be venturesome at this time to express an

[1] Published with the permission of the Commissioner of Fisheries.

[2] The formula actually computed from the analytical data is $C_8H_{14}NO_6$, but $C_8H_{15}NO_6$ is the one usually given because it corresponds to the hypothesis.

opinion as to the nature of the latter fraction. The efforts to isolate it for detailed study have not been successful thus far, but the work in this direction is continued.

The volatile acid given off, of which acetic is the more predominant constituent, does not represent a component part of the molecule. It is a decomposition by-product of the glucose. It is possible to lower greatly the yield of sugar by hydrolyzing chitin with strong acid or by raising the temperature or increasing the duration of the hydrolysis. A great evolution of volatile acid from the chitin will occur simultaneously. The very small quantity of acid formed even in the cold must be likewise attributed to the slow oxidative action of the strong sulphuric acid which must be used in order to dissolve the chitin.

Assuming that the empirical formula for chitin is correct (elementary analyses are in progress now to verify this) we may interpret the above facts in its light, without recourse to the hypothesis that the chitin molecule contains an acetyl group. If we assume that the chitin is a polymere of eight $C_6H_{11}NO_6$ molecules, this should yield on hydrolysis seven molecules of glucosamin, $C_6H_{13}NO_5$, one molecule of glucose, $C_6H_{12}O_6$, and one molecule of the yet unidentified nitrogenous fraction. As the amino groups are cleaved off in the hydrolysis, we get altogether eight glucose molecules to seven ammonia nitrogens and one residual nitrogen. Theoretically, then, the chitin molecule should yield 81.1 per cent. of glucose, and 87.5 per cent. of amino nitrogen and 12.5 per cent. of nitrogen in a stable combination. The facts obtained by hydrolysis agree remarkably with these theoretical expectations.

I could hardly enter here upon a discussion of the bearing of these results further than to say that monoacetylglucosamine, or for that matter monoacetyldiglucosamine, have no relation to chitin. They are secondary products, and are formed after the chitin molecule has been broken down by the action upon it of the sulphuric acid.

S. MORGULIS

THE CREIGHTON MEDICAL COLLEGE,
OMAHA, NEB.

OUTLIERS OF THE MAXVILLE LIMESTONE IN OHIO NORTH OF THE LICKING RIVER[1]

IT is well known to those familiar with Ohio geology that the Maxville limestone is the uppermost formation of the Mississippian System found in the Ohio scale, that its outcrop is limited in extent, patchy in character, and that the overlying Pennsylvanian beds rest upon it unconformably. Up to the present, all the known outcrops of this formation occur south of the Licking River in central Ohio and they lie in a belt ten or twelve miles wide, which extends from the above river on the north to the Ohio River on the south.

It has long been supposed that the formation once extended northward to northern Ohio and was removed by late Mississippian erosion. The supposition was based upon the presence of lime cobblestones more or less silicified which are found in places in the bottom of the Coal Measure basal conglomerate, and which were said to carry Mississippian fossils. Since no other Mississippian limestone was known to occur in the state, it was concluded the cobble stones must have been derived from the Maxville.

It is the purpose of the writer to (1) point out the northward extension of this limestone, to (2) throw further light on the origin of the cobble stones, and to (3) emphasize a reason for the absence of the limestone in northern Ohio.

Beginning at the Licking River various outcrops of this limestone were found as far as forty miles north of the city of Zanesville in a belt ten to twelve miles wide. They invariably occur in isolated patches, are unconformable with superjacent beds, vary in thickness from two to nine feet, and are clearly erosion remnants of a former continuous stratum. Where it is not weathered it presents the same blue-gray, fine-grained, compact character found far to the southward. In places it is fairly fossiliferous, and when fully weathered there remains a residual ocherous earth of deep yellow to chocolate color, mingled with silicious concretions. The latter weather

[1] Read before Section E, A. A. A. S., Columbus meeting, 1915.

nearly round, are usually yellowish to white in color, and generally carry fossils of coral, brachiopods, and bryozoans common to the limestone.

At many places between outcrops of the limestone occur beds of limestone cobbles which are more or less silicified and in all respects identical with those found in the disintegrating limestone. Furthermore, upon noting their elevations, these isolated beds of cobble stones are found to lie in the plane of the limestone—never above it, and only scattered or displaced cobble stones are found below the plane. These facts point unmistakably to the limestone as the source of the cobbles and bear evidence of the former presence of the limestone at all points where these beds occur.

Wherever the Mississippian-Pennsylvanian contact dips much below the plane of the Maxville limestone, little or no trace of the limestone was found. Where the contact is not far below this plane, silicified cobble stones are often found in the base of the Coal Measure basal conglomerate which are identical with the residual cobbles of the limestone. Within the belt considered the contact sometimes falls 100 feet or more below the Maxville plane and all such places have been found to be clearly defined valleys which trenched the Mississippian surface.

It is now known that the Maxville limestone is found two thirds of the distance across the state with strong probability of still further extent formerly.

The Berea sandstone, lying at or near the base of the Mississippian system, is an excellent datum plane. Using it for this purpose in the general direction of the Maxville outcrop, it is found that the Berea-Maxville interval increases northward. In Vinton County, in the southern part of the state, the interval between the top of the Berea and the top of the Maxville is about 650 feet; at Rushville, in the eastern Fairfield County, about 800 feet; at New Castle, in Coshocton County, about 840 feet; near Killbuck, in southern Holmes County, about 870 feet; and twenty miles north of the last point in central Wayne County east of Wooster a thickness of 900 feet of shale and sandstone above the Berea does not quite reach the Maxville horizon. Northward from Wayne County the total thickness of the Mississippian strata decreases notably, due to greater erosion in late Mississippian time. In northeastern Ohio the Pennsylvanian beds lie, commonly, only about three to four hundred feet above the Berea, and in the old Mississippian river valleys, so clearly defined in this area, the Sharon conglomerate sometimes lies but 100 feet above the Berea. These thicknesses are clearly far below the Maxville horizon.

Central Wayne County is about fifty miles from Cleveland and 150 from Portsmouth on the Ohio River, the region of the southern outcrops of the Maxville. If the plane of the Maxville be projected northward to Cleveland with the slowly increasing interval between it and the Berea, the Maxville would lie about 1,050 feet above the Berea.

In the light of these facts it is apparent that the Maxville will not be found in northern Ohio, and that outcrops may not be expected beyond northern Holmes, or central Wayne County.

It will be noted further that these figures reveal the interesting fact that the Mississippian system thickens northward, although thinnest in the north now as a result of erosion.

Mount Union College G. F. Lamb

A METHOD FOR MAINTAINING A CONSTANT VOLUME OF NUTRIENT SOLUTIONS

With plant experiments involving the use of various nutrient solutions it is important that there should be no undue loss of solution due to evaporation or the taking up of the solution by the plant, as it has been shown that an increase in concentration due to a loss of water by evaporation or transpiration may seriously impair results.

To save time in refilling the culture vessels to a constant volume the following simple method has been devised. It works automatically and keeps the solution at a constant level, and the only attention required is to refill the reservoir when empty.

A drawing will show the arrangement of the device, which consists of a flask or bottle of

any convenient shape fitted with a two-holed rubber stopper through which are inserted two glass tubes of 5 mm. bore, one projecting 5 cm. and the other 2.5 cm. from the stopper.

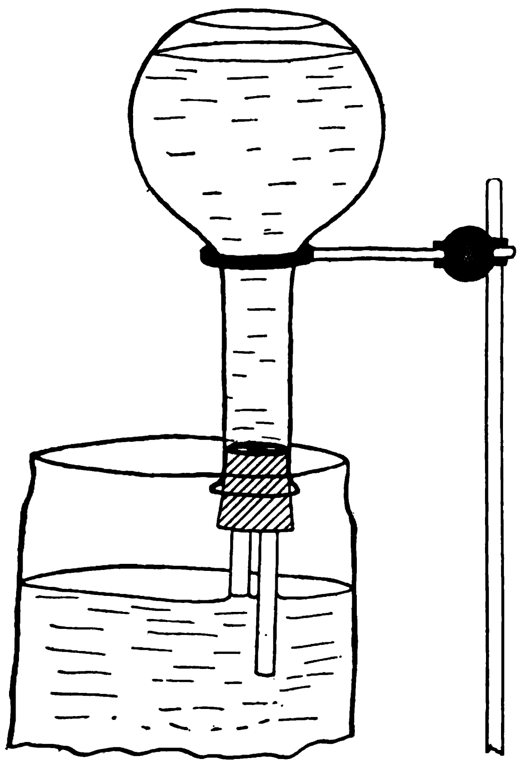

Fig. 1.

The operation of the apparatus is as follows: the flask is filled with the nutrient solution which is used in the culture jar and inverted above it (or the glass tubes can be bent so that the flask is above and at one side of the jar, and thus out of the way of the plants). The solution flows out of the longer tube, the shorter tube allowing the ingress of air. This flow of solution from the longer tube may be stopped by lowering the flask until the end of the shorter tube comes in contact with the solution in the culture jar, which seals the end of this tube and prevents the entrance of air and thus the exit of solution from the longer tube. The flask is adjusted so that the lower end of the shorter tube is at a level desired as the constant one, and as soon as the solution sinks (about 1.5 mm.) below this level either from evaporation or the taking up of the solution by the plant the air enters through the lower end of the shorter tube, allowing the exit of solution through the longer tube until the level of solution in the culture jar rises to the end of the shorter tube, which is sealed until the water level sinks again. In the case of culture experiments where the mouth of the culture jar is covered it is only necessary to bore two holes to admit the two tubes projecting from the reservoir.

Orton L. Clark
Massachusetts Agricultural Experiment Station

SOCIETIES AND ACADEMIES

THE BOTANICAL SOCIETY OF WASHINGTON

The 112th regular meeting of the Botanical Society of Washington was held in the Assembly Hall of the Cosmos Club, Tuesday, April 4, 1916. Fifty-two members and five guests were present. Harry R. Fulton, George L. Keenan, Lester A. Round, J. F. Clevenger, C. E. Temple, A. E. Aldous, Victor Birckner and Forrest S. Holmes were elected to membership. The following papers were presented:

Botanical Explorations in South America: Dr. J. N. Rose.

Plants Domesticated in Peru: Mr. O. F. Cook.

Mr. Cook gave a brief account of the agriculture of the Incas with their wonderful terraces and system of irrigation. Among the plants domesticated by them were maize, beans, lima beans, peanuts, quinoa (*Chenopodium quinoa*), red peppers (*Capsicum*), mandioca, tomatoes, passion fruits, sweet potatoes, tuberous *Tropæolum* and *Oxalis*, arracacha (a celery-like plant), squashes and pumpkins, gourds; and among the fruits, chirimoyas, lucumas and pepinos. The narcotic coca, from which cocaine is now prepared, was also grown. Mr. Cook's paper will be embodied in a forthcoming article in the *National Geographic Magazine* for May, 1916.

The 113th regular meeting of the Society was held in the Assembly Hall of the Cosmos Club, Tuesday, May 2, 1916. Mr. Frank N. Meyer, geographical explorer of the U. S. Department of Agriculture, was elected to membership. The program consisted of the following papers:

Dr. Edward L. Greene, an Appreciation: H. H. Bartlett.

As it was impossible for Mr. Bartlett to be pres-

ent at the meeting, the paper was read by title. It appeared in full in *Torreya* for July, 1916.

Winter Rape and Adulterants of This Seed (with lantern): EDGAR BROWN.

Five types of plants raised from seed imported into the United States under the name of rape were briefly described and illustrated. The Dutch and German sources of the winter rape seed normally used in this country for the production of forage having been shut off, seed was imported from other sources, including winter rape from England, France and Japan, annuals of no forage value from Argentina, France, China and Japan, and biennials of no forage value from France and Japan.

An Economic Amaranthus of Ancient America (with exhibition of specimens and lantern): W. E. SAFFORD.

Among the tributes paid to Montezuma by the pueblos of Mexico was a certain grain of ivory whiteness and more minute than a mustard seed, called by the Aztecs *huauhtli*. Eighteen imperial granaries were filled with it each year, each having a capacity of about 9,000 bushels. In some parts of Mexico, at times when maize was scarce, this seed was used in its stead and along the Pacific coast it was an important food staple. Cabeza de Vaca noticed it in Sonora in 1536. Its most important use was in religious ceremonies, when a paste, called *tzoalli*, was made of it together with maguey syrup, and images of the god Uitzilipuztli were molded of it. After having been adorned with beautiful ornaments and carried in procession, the image was carried to the top of the pyramidal temple in the city of Mexico. Sacrifices were made to it, including human beings, and the next day it was broken up into fragments and served as communion to the people. For a long time the botanical identity of this seed was unknown. The late Edward Palmer while making collections in the states of Sinaloa and Jalisco, found an *Amaranthus* growing both in cultivation and spontaneously. Its ivory-white seeds, resembling fish-eggs, corresponded exactly with the huauhtli as described by early writers. Moreover, its local name, "guaute," is only a variation of the Nahuatl *huauhtli*. Near Guadalajara Dr. Palmer found a paste made of this seed and sugar offered for sale in the form of strings of dumplings enveloped in corn husks, under the name of "suale," a corruption of the Nahuatl *tzoali*. He collected botanical specimens of the plant producing the seed, which proved to be an *Amaranthus*, evidently a white-seeded form of *A. paniculatus*. Although Dr. Palmer did not realize that he had rediscovered an important economic plant of the Aztecs, his botanical specimens together with his field notes, found by the writer in the U. S. National Herbarium, served to establish the identity of the sacred huauhtli. The possibility of cultivating this *Amaranthus* in suitable situations in the southwestern United States was suggested by the writer. Very closely allied plants, also producing white seeds, are cultivated as grain crops in India, Thibet, South America and Africa. Of the existence of this particular form in pre-Columbian America there can be no doubt. It remains to be determined whether or not the Asiatic and African plants were endemic in the countries where they are now cultivated, or were introduced there after the discovery of America. Mr. Safford's paper will appear in full in the Proceedings of the Ninth Congress of Americanists.

Fungus Fairy Rings in Eastern Colorado and Their Effect on Vegetation (with lantern): H. L. SHANTZ AND R. L. PIEMEISEL. To be published by the U. S. Department of Agriculture.

Report on the Local Flora: A. S. HITCHCOCK.

W. E. SAFFORD,
Corresponding Secretary

THE SOUTH DAKOTA ACADEMY OF SCIENCE

THE second annual meeting of the South Dakota Academy of Science was held in Watertown, South Dakota, November 27 and 28. The following papers were read:

President's address, H. I. Jones.

"The Locust Outbreak in South Dakota in 1916," by H. C. Severin and Geo. Gilbertson.

"Water Culture," R. J. Gilmore.

"The Plankton of the James River," W. H. Griffeth.

"Soil Fertility in South Dakota," J. G. Hutton.

"A Study of Lipase," H. I. Jones.

"Aluminum Phenolate," A. N. Cook and G. N. Quam.

"The Chemistry of the Cell," J. M. Scott.

"Correlation in Corn," A. N. Hume.

"Notes on Sodium Cyanide," W. J. Sharwood.

The officers for 1916–17 will be:

President, A. N. Cook, Vermillion.

First Vice-president, A. N. Hume, Brookings.

Second Vice-president, L. G. Atherton, Madison.

Secretary, R. J. Gilmore, Huron.

Treasurer, H. Loomis, Brookings.

The next meeting will be held at Brookings in October, 1917.

R. J. GILMORE,
Secretary

SCIENCE

FRIDAY, DECEMBER 22, 1916

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

SIMON NEWCOMB

THE numerous published biographical sketches of Simon Newcomb all fail to set forth accurately the full extent of the world-wide recognition of his contributions to scientific knowledge, and the breadth of his interests and activities. No other American scientist has ever achieved such general recognition of eminence. It seems desirable, therefore, to assemble the facts to fill this lacuna.[1] The plan which Monsieur Lebon has employed in the admirable *Savants du Jour* series suggested the form of the following synoptic notes.

These notes were prepared several years ago in consultation with members of Professor Newcomb's family, and after inspection of his remarkable collection of diplomas, medals, decorations, and certificates of membership and of other honors. This collection became the property of the nation in 1909, and it is now prominently displayed in the historical section of the National Museum in the Smithsonian Institution at Washington.

Born at Wallace, Nova Scotia, March 12, 1835

1853: Came to the United States.

1854: Teacher in a country school at Massey's Cross Roads, Kent Co., Md.

1855: Teacher in the village school at Sudlersville, Md.

1855, May 26: First publication, a letter in *The National Intelligencer*, Washington, D. C.

1857, Jan.–Sept. 1861: Computer in the Nautical Almanac office, then located at Cambridge, Mass. (it has been in Washington, D. C. since 1866). See also 1860, 1861.

1858, July 2: B.Sc., Harvard University, Cambridge, Mass. See also 1875, 1879–80, 1884, 1898–99, 1906.

[1] A complete bibliography of Newcomb's life and works, by the writer, will soon be published elsewhere.

1859, Aug.: Elected Member of the American Association for the Advancement of Science. See also 1874, 1876.

1860: Nautical Almanac office dispatched an expedition, in charge of S. Newcomb and W. Ferrel, to observe the total solar eclipse, in July, north of Lake Winnipeg, Canada. See also 1857, 1869, 1870, 1878.

1860, Jan. 25: Elected Fellow, in the Division of Mathematics and Astronomy, of the American Academy of Arts and Sciences, Boston. See also 1870, 1880.

1861, Sept. 21: Commissioned Professor of Mathematics in the United States Navy by Abraham Lincoln. See also 1877, 1897.

1863, Aug. 4: Married to Miss Mary Caroline Hassler, daughter of Dr. C. A. Hassler, U. S. N., and granddaughter of Ferdinand Rudolph Hassler, the founder of the U. S. Coast Survey.

1869, Sept. 1: Elected Member of the National Academy of Sciences, Washington, D. C. See also 1878, 1881, 1883, 1902, 1903.

1869: Sent by the U. S. government to Des Moines, Iowa, to observe the Solar Eclipse, Aug. 7. See also 1860.

1870: Sent by the U. S. government to Gibraltar to observe the Solar Eclipse, Dec. 22. See also 1860.

1870, May 24: Elected Associate Fellow (number of such limited to 14 in the Division of Mathematics and Astronomy) of the American Academy of Arts and Sciences, Boston. See also 1860.

1870, Nov. 11: Guest at a dinner of the Royal Astronomical Society Club, London. He was also a guest at dinners of this club on the following dates: Jan. 8, 1875; Jan. 12, 1883; June, 1896; June 9, 1899. See also 1872, 1874.

1871, May 13: Elected Member of the Philosophical Society of Washington. See also 1879–80, 1908.

1871: Appointed Secretary of the Commission, created by Congress for the purpose of observing the Transit of Venus, Dec. 9, 1879, and which organized the expeditions sent out by the United States government. See also 1882.

1872, Nov. 8: Elected Associate Member of the Royal Astronomical Society, London. See also 1870.

1873: Appointed lecturer in Columbian (afterwards George Washington) University. Resigned 1884. See also 1874, 1884.

1873, Aug. 22: Elected at Hamburg a member of the Astronomische Gesellschaft. See also 1887.

1873, Dec. 16: Appointed correspondent of the Observatoire de Paris.

1874: Elected Fellow of the American Association for the Advancement of Science. See also 1859.

1874: LL.D., Columbian University, Washington, D. C., now George Washington University. The following is quoted from the diploma: "Virum clarum Simonem Newcomb coeli dimetiendi stellarumque errantium librandarum peritissimum Legum Doctorem, etc." Since also 1873.

1874, Jan. 19: Elected Correspondent of the Académie des Sciences de l'Institut de France. See also 1895, 1906.

1874, Feb. 13: Awarded the gold medal of the Royal Astronomical Society, London, for his "tables of Neptune and Uranus and other mathematical works." See also 1870.

1875: Offered the directorship of the Harvard Observatory. See also 1858.

1875, Feb. 8: Master of Mathematics and Doctor of Natural Philosophy, University of Leyden, on the celebration of the 300th anniversary of its founding.

1875, July 1: LL.D., Yale University, New Haven. See also 1877.

1875, Nov. 10: Elected a Foreign Associate of the Kungliga Svenska Vetenskapsakademien (Royal Swedish Academy of Sciences), Stockholm.

1875, Dec. 29 (Jan. 10): Elected a Corresponding Member of the Imperatorskaja Akedemija naŭk (Imperial Academy of Sciences), Petrograd. See also 1896, 1897.

1876, June 27: Elected Corresponding Member of the Königliche Bayerischen Akademie der Wissenschaften, Munich.

1876, Aug. 30: Elected President of the American Association for the Advancement of Science. Delivered retiring address in 1878. See also 1859.

1877: Elected member of the Yale Alumni Association. See also 1875.

1877, Sept. 15: Became the senior Professor of Mathematics in the U. S. Navy—with the relative rank of Captain. Appointed Superintendent of the American Ephemeris and Nautical Almanac Office. See also 1857, 1861, 1906.

1877, Nov. 27: Elected Associate of the Kungliga Vetenskaps-Societeten (Royal Scientific Society), Upsala, Sweden.

1877, Dec. 13: Elected Foreign Member of the Royal Society, London. The number of such members is limited to 50. See also 1890, 1895.

1878: Sent by U. S. government to Separation, Wyoming, to observe the total Solar Eclipse, July 29. See also 1860.

1878, Jan. 18: Elected Member of the American

Philosophical Society, Philadelphia. See also 1903, 1906, 1908, 1909.

1878, May 18: Elected Foreign Member of the Hollandsche Maatschappy der Wetenschappen, Harlem. The only other American Foreign Member was J. D. Dana. (Number of Foreign Members limited to 60.) See also 1880.

Awarded the Huygen's medal by the Society which had "resolved to award biennially a medal to the individual who, by his researches and discoveries or inventions during the previous twenty years had, in the judgment of the Society, distinguished himself in an exceptional manner in a particular branch of science."

1878, May 20: Elected Honorary Member of the Cambridge [England] Philosophical Society.

1878, Aug.: Appointed by the National Academy of Sciences on a Committee to plan for surveying and mapping the territories of the United States. See also 1869.

1879–80: President of the Philosophical Society of Washington. See also 1871.

1879–80: Lecturer on Political Economy at Harvard University. (Four Lectures.) See also 1858.

1880, May 26: Delegate of the Hollandsche Maatschappy der Wetenschappen at the celebration of the 100th anniversary of the founding of the American Academy of Arts and Sciences at Boston. See also 1860, 1878.

1881: Elected Honorary Foreign Fellow (limited to 36) of the Royal Society of Edinburgh.

1881: Became an administrator of the Watson Fund on behalf of the National Academy and continued in active service in connection with it (chairman of the Board of Trustees from 1887) until his death. The fund was founded by the will of Professor J. C. Watson and it provided the means for support of research and investigation and the award of the Watson Gold Medal. See also 1869.

1881: Elected Home Secretary of the National Academy of Sciences; held the office till 1883. See also 1869.

1881: Appointed by the National Academy of Sciences chairman of a Committee on Questions of meteorological science and its applications. Committee discharged in 1884. See also 1869.

1881–82: Delivered twelve lectures at the Lowell Institute, Boston, on the "History of Astronomy."

1881, March 9: Elected Foreign Member of the Kungliga Fysiografiska Sällskapet (Royal Physiographical Society), Lund, Sweden.

1882: Sent by the U. S. government to Cape of Good Hope to observe the transit of Venus, Dec. 6. See also 1871.

1882, Mar. 16: Elected Honorary Member in the Section of Science of the Royal Irish Academy, Dublin. Such members are limited to 30, of whom one half at least must be foreigners.

1883: Elected Vice-president of the National Academy of Sciences. He continued in this office till 1889. See also 1869.

1883, June 7: Elected Corresponding Member of the Königliche Preussischen Akademie der Wissenschaften, Berlin. See also 1899.

1884: LL.D. Harvard University, Cambridge, Mass. In the diploma occur the words: "Simon Newcomb virum summo ingenio præditum Mathematicum acutissimum rerumque coelestium peritissimum." See also 1858.

1884: Appointed Member of the Board of Examiners of the International Electrical Exhibition of The Franklin Institute of the State of Pennsylvania. See below.

1884: Appointed Professor of Astronomy in the Corcoran Scientific School of Columbian (since 1904 George Washington) University. Resigned 1886. See also 1873.

1884, July 22: Appointed by President Arthur, Commissioner of the National Conference of Electricians at The Franklin Institute, Philadelphia. See above.

1884, Aug.: Elected Corresponding Member of the British Association for Advancement of Science. See also 1904.

1884, Oct.: Appointed Professor of Mathematics and Astronomy at Johns Hopkins University, and lectured there till Jan. 1, 1894. He was reappointed in 1898 and retained the position till 1900. See also below, 1897, 1899, 1900, 1901, 1902.

1884–94, 1899 and 1900: Editor-in-Chief of the *American Journal of Mathematics*, Johns Hopkins University. Associate Editor; 1878, 1879, 1895–98, 1901–1909. See also 1884.

1885: Elected the first President of the American Society for Psychical Research. Reelected President of the Society in 1886.

1885, June 18: Asked if he would accept the Presidency of the University of California.

1886: Ph.D., University of Heidelberg, Germany, on the celebration of the 500th anniversary of its founding. Degree conferred *in absentia*.

1886, Jan. 15: Elected Honorary Member (at the same time as Chrystal and Sylvester) of the Association for the Improvement of Geometrical Teaching, afterwards the Mathematical Association, London.

1886, Oct. 11: Elected Associate of the Liverpool Astronomical Society.

1886, Nov. 6: Elected President of the Alumni Association of the Lawrence Scientific School in Harvard University. See also 1858.

1887: President of the Political Economy Club of America.

1887: Elected one of the eight members of the Council of the Astronomische Gesellschaft, an international astronomical society that meets once in two years. See also 1873.

1887: The Russian Emperor orders his portrait to be painted and placed in the gallery of famous astronomers at the Imperial Observatory at Pulkovo. See also 1889.

1887, Jan. 4: Elected Member of the Anthropological Society, Washington, D. C.

1887, Apr. 13: LL.D., Columbia University, New York, on the occasion of the celebration of the "one hundredth anniversary of the Revival and Confirmation by the Legislature of the State of New York of the Royal Charter granted in 1754."

1887, Apr. 19: Elected Honorary Member of the Manchester Literary and Philosophical Society, Manchester, England.

1888: Imperial University of Tokyo, Japan, officially presents him with a pair of bronze vases of exquisite workmanship and design and great intrinsic value.

1888, Nov. 3: Elected Correspondent of the Königliche Gesellschaft der Wissenschaften, Göttingen. See also 1907.

1889: Presented with a rare vase of jasper on a pedestal of black marble, six and one half feet high, which, says Mr. Nyren's letter announcing the gift, "in recognition of these merits, His Majesty the Emperor has graciously sent as a present for you from the observatory at Pulkovo." An attached silver label has the following inscription: "A Monsieur le Professeur Simon Newcomb de la part de l'Observatoire Central Nicolas de Poulkovo 7/19 août, 1889." See also 1887.

1889, Sept.–Nov.: Foreign Associate of the Commission of Organization of the Congrès International de Chronométrie. (In connection with the World's Exposition, 1889.)

1890, June 4: Elected a Member of the American Academy of Political and Social Science, Philadelphia.

1890, Nov.: Awarded the Copley Medal by the Royal Society, London, for contributions to the progress of gravitational astronomy. Franklin was the first recipient of this medal, in 1753. The medal was accompanied by a cheque for £50. See also 1877.

1891, May 4: Elected Honorary Member (number restricted to 50) of the New York Academy of Sciences.

1891, May 4: One of the twenty-one eminent scientific men elected Honorary Members of the Royal Institution of Great Britain, on the celebration of the Faraday Centenary. Diploma presented by the Prince of Wales on June 17.

1891, Aug.: Elected Honorary Member of the Committee of Organization for the Fifth International Congress of Geologists, Washington.

1891, Aug. 1: LL.D., Edinburgh University, Scotland. This degree was first offered in connection with the celebration (April 17, 1884) of the 300th anniversary of the founding of the university, and finally conferred *in absentia*.

1891, Nov. 3: Elected Honorary Fellow (number limited to 15) of the Astronomical and Physical Society of Toronto, now the Royal Astronomical Society of Canada.

1891, Nov. 7: Elected a Member of the New York Mathematical Society. In 1894 this society became the American Mathematical Society. It was on Newcomb's suggestion (letter dated Jan. 29, 1891) that the *Bulletin of the New York Mathematical Society* (started October, 1891) was devoted to the interests of applied as well as of pure mathematics. See also 1896.

1891, Dec. 15: Elected Associate (number limited to 50) of L'Académie Royale des Sciences, des Lettres et des sciences morales et politiques et des Beaux Arts de Belgique, Brussels.

1892, July 6: Sc.D., Dublin University, Ireland, at the celebration of the tercentenary of its foundation.

1892, Dec. 7: Phil.Nat.D., University of Padua, Italy, on the occasion of the celebration of the 300th anniversary of the appointment of Galileo as a Professor. Degree conferred *in absentia*.

1894, May 29: Announced that "Aristides" (= S. Newcomb) was the winner of the first prize, $150, of two "Citizenship Prizes" offered in 1893 by the Anthropological Society of Washington for the best essay on a given topic and not over 3,000 words in length. The essay was entitled: "The Elements which make up the most useful citizens of the United States," and was published in the *American Anthropologist* for 1894.

1895–1903: Mathematical Editor of SCIENCE.

1895: Appointed a judge of Instruments of Precision at the Atlanta Exposition.

1895: Awarded the *Astronomical Journal* prize of

$400 for the "most thorough discussion of the theory of the rotation of the earth, with reference to the recently discovered variation of latitude."

1895, June 17: Elected one of the eight Foreign Associate Members of the Académie des Sciences de l'Institut de France, to succeed Helmholtz, the celebrated physiologist. It is said that Newcomb was the first native American since Franklin so honored. See also 1874.

1895, Aug. 1: Elected Foreign Associate of the Astronomical Section of the Reale Accademia dei Lincei, Rome. (Number of astronomers limited to 8.) See also 1906.

1895, Nov. 21: Appointed a Delegate on the part of the United States to the Conference, held in London, July, 1896, under the auspices of the Royal Society, to discuss the question of preparing, by international cooperation, an adequate catalogue of scientific literature. See also 1877.

1896: Elected an Honorary Member of the Inperatorskaja Akademija naūk (Imperial Academy of Sciences), Petrograd. (Number limited to 50.) See also 1875.

1896, Jan. 4: Elected an Officer of the Legion of Honour of France. The grade of Officer, which is next above that of Chevalier, is limited to 4,000, mostly Frenchmen. Simon Newcomb was authorized by Congress to receive this decoration (see *Congressional Records*, March 3, 1897); for the Constitution of the United States provides (Art. 1, Sec. 9, Par. 7): "No title of nobility shall be granted by the United States; and no person holding any office of profit or trust under them shall, without the consent of Congress, accept of any present, emolument, office or title, of any kind whatever, from any king, prince or foreign state."

1896, May: Delegate to the Conference at Paris on the Astronomical Constants.

1896, June 15–16: Invited guest at celebration in Glasgow of Lord Kelvin's Jubilee.

1896, June 16: LL.D., Glasgow University, Glasgow.

1896, June 18: Sc.D., Cambridge University, England. In introducing Simon Newcomb, the public orator said that his distinction was owing to a great degree to his comparative researches in ancient lunar observations.

1896, Oct. 22: LL.D., Princeton University, Princeton, at the celebration of the sesqui-centenary of its foundation.

1896, Dec. 30: Elected President of the American Mathematical Society, New York, for two years. Delivered Presidential Address Dec. 29, 1897. See also 1891.

1897: Awarded the Schubert Prize (900 roubles = $460.80) by the Imperatorskaja Ajademija naūk, Petrograd. This was the third time that the prize had been awarded. The award is made biennially for notable achievement in theoretical astronomy. The prize is the income from a foundation of 10,550 roubles in honor of F. F. Schubert, a general in the infantry and a former member of the Academy. See also 1875.

1897, Jan. 4: Elected a Member of the Columbia Historical Society of Washington, D. C.

1897, Feb. 12: Elected a Corresponding Member of the Imperatorskaja Russkoje Geografičeskoje obščestvo (Imperial Russian Geographical Society), Petrograd.

1897, Feb. 22: At the celebration of the 21st Anniversary of the founding of Johns Hopkins University, requested by the faculty and friends to sit for a portrait to be given to the University. This painting was executed by R. G. Hardie and was reproduced in the *American Journal of Mathematics* for 1899. See also 1884.

1897, Mar. 1: Elected a Foreign Associate of Società Italiana delle Scienze (detta dei XL.) Rome. The society has 40 Italian and 12 Foreign Associate members in the Class of Physics-Mathematics. He was the only American in the class. See also 1902, 1906.

1897, March 12: Placed on the retired list of the U. S. Navy by reason of age and therefore ceased to be Superintendent of the American Ephemeris and Nautical Almanac. See also 1857.

1897, June 30: Elected Honorary Corresponding Member of the Royal Society for the Encouragement of Arts, Manufactures and Commerce (commonly called the Royal Society of Arts), London.

1897, Nov. 27: The first recipient of the Bruce Gold Medal, from the Astronomical Society of the Pacific. In 1897, Miss Bruce gave to this Society "a sum of money for the foundation of a gold medal, to be awarded annually as a recognition of services to astronomy, and to be given to the one judged most worthy, without restriction as to race, nationality or sex. No person shall be twice a recipient." In 1891, Miss Bruce gave Professor Pickering $6,000, to be distributed for the promotion of astronomical research. A portion of this amount was assigned to Professor Newcomb.

1898: Cape Newcomb of the Hoyt Islands, Hubbard Bay, West Greenland, is named after

Simon Newcomb. (See *National Geographic Magazine*, Volume 9, page 3.)

1898–99: Appointed by the Board of Overseers of Harvard College, a member of the Committee to visit the Observatory. See also 1858.

1898, Feb. 27: Elected Foreign Associate of the Reale Istituto Veneto di Scienze, Lettre ed Arti, Venice.

1898, Mar. 16: Elected Honorary Member of the Colonial Society of Massachusetts. (One of nine Honorary Members.)

1898, Apr. 23: Elected Honorary Member of the mathematics-natural science section of the Koninklijke Academie van Wetenschappen, Amsterdam. (Number limited to 20.)

1899, April: Appointed by Johns Hopkins University, Baltimore, as Delegate to the Jubilee celebration of Sir George G. Stokes at Cambridge, England, June 1–2. See also 1884.

1899, June 8: D.C.L., Oxford University, England.

1899, June 22: Elected Associate Corresponding Member of the Reale Istituto Lombardo di Scienze e Lettere, Milan.

1899, July 3: Elected Foreign Correspondent of the Bureau des Longitudes, Paris. Number limited to 10.

1899, Sept. 8: Elected the first President of the Astronomical and Astrophysical Society of America. The Society was organized at the third conference of Astronomers and Astrophysicists held at the Yerkes Observatory in accordance with arrangements made by a committee (of which S. Newcomb was chairman) appointed at the second conference held at Harvard Observatory in August, 1898. S. Newcomb was president of the society for six consecutive years.

1899, Oct. 9–10: Delegate from National Academy of Sciences to a conference at Wiesbaden (called by the Königliche Preussischen Akademie der Wissenschaften, Berlin) for the purpose of organizing an international association of learned societies. See also 1883.

1900, June 11: LL.D., University of Cracow, Austria, on the celebration of the 500th anniversary of its foundation. Degree conferred *in absentia.*

1900, Nov. 7: "With grateful recognition of the valuable counsel you have given to this university since its organization, the academic council has unanimously recommended to the Trustees that you be appointed Emeritus Professor of Mathematics [at Johns Hopkins University] and the Board of Trustees with like unanimity approved this recommendation." See also 1884.

1901, Feb. 22: One of the two to receive the first award of the Sylvester Prize of Johns Hopkins University. The prize was a handsome bronze medallion of the late Professor Sylvester, framed in oak. It was inscribed: "To Simon Newcomb, U. S. N., LL.D., Professor of Mathematics and Astronomy in the Johns Hopkins University, 1884–1900. In recognition of his distinction and his service." In the course of the ceremonies, President Gilman announced the award as follows: "The first impression of this tablet is presented to Lord Kelvin, who lectured here on 'The Nature of Light,' in 1884. . . . The second copy of the tablet is now offered to Professor Simon Newcomb, a distinguished astronomer, who has been a friend of the University from its inception, and who guided the affairs of the Mathematical Department for many years." See also 1884.

1901, Oct.: Elected Honorary Member of the Heidelberg Literary Society, Heidelberg University, Tiffin, Ohio.

1901, Oct. 8/21: Elected Honorary Member of the Russkoje Astronomičeskoje obščestvo, Petrograd.

1901, Nov. 6: Elected Honorary Member of the Royal Society of New South Wales, Sydney, Australia.

1902, Feb. 21: LL.D., Johns Hopkins University, at the celebration of the twenty-fifth anniversary of the founding. "In recognition of his preeminent attainments and important discoveries in science." See also 1884.

1902, Feb. 26: Guest at a banquet, given by eminent citizens of New York, in honor of H. R. H. Prince Henry of Prussia. He was one of the 94 participants chosen as "Captains of Industry" in the United States.

1902, Apr. 14: Elected Honorary Member of the Sociedad Astronomica de Mexico.

1902, June 1: Presented to King Vittorio Emanuele III. of Italy just after a meeting of the Reale Accademia dei Lincei. See also 1897.

1902, Sept. 6: Math.D., University of Christiania, Norway, in connection with the celebration of the Centenary of the birth of Niels Henrik Abel. Professor Newcomb went as delegate from the National Academy of Sciences. During the celebration he was presented to King Oscar of Sweden and Norway. See also 1869.

1903: Appointed by the Trustees, one of five members of the Advisory Committee in Astronomy of the Carnegie Institution of Washington. In 1903, Professor Newcomb received a grant of $3,000, and in 1904 a grant of $2,500, in 1905, $7,500, in 1906, $5,000, in 1907, $5,000 and in 1908, $5,000, from this Institution for expenses in connection with his investigations.

1903: Elected Foreign Secretary of the National Academy of Sciences. Held the office till his death. See also 1869.

1903: Appointed delegate to represent the National Academy of Sciences at the meeting of the International Association of Academies, which occurred in London, June 4, 1903. See also 1869.

1903, Feb. 26: Requested to send a letter to be read at the celebration of the twenty-fifth anniversary of the death of Fra Angelo Secchi, S.J., at Rome, Italy.

1903, Apr.: By the American Philosophical Society appointed a Member (one of 26) of a Committee to organize the Bicentenary Celebration of Franklin's birth. See also 1878.

1903–04: President of the International Congress of Arts and Sciences, Louisiana Purchase Exposition, which met at St. Louis, September 19–25, 1904. He received a diploma "for distinguished services in promoting" the Congress. As President of the Congress he was delegated to visit France and England to invite scientists of these countries to participate in the Congress. On March 29 he gave a dinner at Paris, for a number of French scientists. He was presented to President Loubet of France about this time. See also 1906.

1903, June: Presented to King Edward VII. of England.

1904: One of the Vice-presidents of the Mathematics and Physics Section of the British Association for the Advancement of Science. See also 1884.

1904, May 20: Elected Corresponding Member of the Kaiserliche Akademie der Wissenschaften, Vienna. (Limited to 80 members.)

1904, June: LL.D., University of Toronto. The Senate of the University voted on June 6, 1900, to confer the degree, but it was not till 1904 that Professor Newcomb could attend a convocation to receive it.

1905, March 5: Elected Corresponding Member of the Reale Accademia della Scienze, Turin.

1905, March 11: Invited by Senator Baron d'Estournelles de Constant, Paris, to be one of the "Membres d'Honneur" of the Comité de Défense des Intérêts Nationaux et de Conciliation Internationale" of which the Baron was Président Fondateur.

1905, Apr. 28: Elected Corresponding Member of L'Institut National Génevois, Geneva.

1905, Nov. 8: By the German Emperor made Knight of the Prussian Order "Pour le Mérite für Wissenschaften und Künste." The Order of Merit is composed of two classes, military and civil. The first class was founded by Frederick the Great in 1740. The second class founded by Frederick William IV., in 1842, for distinction in Science and Art has always been very highly prized. It is the only decoration which Thomas Carlyle would ever accept. Knighthood in this order is limited to 30 Germans and a not larger number of foreigners. At the time of Simon Newcomb's election there were about 20 foreign Knights. The bill granting permission to Newcomb to accept this decoration became law on April 6, 1906.[2] Compare 1896.

1906–07: President of the Cosmos Club, Washington, D. C.

1906, Apr. 17–20: Delegate at the Bicentenary Celebration of Benjamin Franklin's Birth, at Philadelphia, from: (1) Reale Accademia di Scienze, Lettere ed Arti, Padua; (2) Reale Accademia dei Lincei, Rome; (3) L'Académie des Sciences de l'Institut de France, Paris; (4) Società Italiana delle Scienze, Rome. Recipient of one of the Franklin Bronze Medals struck in accordance with an Act of Congress approved April 27, 1904. See also 1874, 1878, 1895, 1897, 1903, below.

1906, June 27: Elected a Member of the Board of Overseers of Harvard University, for 6 years. Simon Newcomb was the first graduate of the Lawrence Scientific School, not already a graduate of the College, who was elected to this body. See also 1858.

1906, June 30: Elected Honorary Member of the Reale Accademia di Scienze, Lettere ed Arti, Padua. See also above.

1906, June 30: Commissioned Rear-Admiral when Congress authorized the President to make promotions of officers who had served in the Civil War and who had been discriminated against by previous laws. See also 1877.

1906, Sept. 25: At the quatercentenary celebration of the founding of the University of Aberdeen, Scotland, on this date various honorary degrees were conferred. Professor Newcomb was invited to be present to receive the degree of LL.D., but he was unable to accept the invitation.

1906, Dec. 8: Bronze plaque sent from Berlin and addressed to "Dr. Simon Newcomb, St. Louis" by Th. Lewald, "Der Reichskommissar für die Weltausstellung in St. Louis, 1904," who wrote: "In commemoration of Germany's participation

[2] On the death of a Knight it is required that the decoration be returned to the German government.

in the International Exposition at St. Louis, 1904, I have had a plaque prepared which forms a lasting memento of the cordial and pleasant relations which prevailed there. I take the liberty of forwarding for your acceptance a specimen with your name engraved on it." The plaque is inscribed on one side "Simon Newcomb, Arta Artis Vincula" and in small letters "Peter Breuer," and on the other side: "Zur Erinnerung an Deutschlands Beteiligung an der Weltausstellung in St. Louis, MCMIV." See also 1903–04.

1907, Jan. 5: Made Commandeur de l'Ordre National de la Légion d'Honneur, France. A bill granting permission to accept this decoration was deemed unnecessary in view of the permission already given to accept the rank of Officer of the Légion d'Honneur.

1907, Feb. 8: Elected one of the 12 Honorary Fellows of the Physical Society, London.

1907, March 22: Elected a Foreign Member of the mathematics-natural science class of the Videnskabs Selskabet (Society of Sciences), Christiania. (Number limited to 100.)

1907, June 3: Elected Honorary Member of the Société Scientifique "Antonio Alzate," Mexico.

1907, July: Lecturer at the Summer School of the University of California.

1907, July 20: Elected Foreign Member of the Königliche Gesellschaft der Wissenschaften, Göttingen. Election royally confirmed Oct. 4. See also 1888.

1908, April 6–11: One of the 11 Vice-presidents and one of the 9 principal speakers of the Fourth International Congress of Mathematicians held at Rome, Italy. He was the only American on the International Committee (61 members) for organization of the Congress. He was also a Delegate from the Smithsonian Institution and the American Philosophical Society. See also 1879.

1908, Aug.: Delegate from the National Geographic Society at Washington to the International Congress of Geography at Geneva, Switzerland.

1908, Aug. 17: Received in audience by Emperor William II. at Wilhelmshöhe, Germany, and lunched with his Majesty and the Empress.

1908, Nov. 13: Appointed one of the Committee of 19 on the "Charles William Eliot Fund."

1908, Dec. 19: Elected President of the Philosophical Society of Washington. See also 1871.

1909, Jan. 1: Elected Vice-president of the American Philosophical Society, Philadelphia, Pa. See also 1878.

1910, July: At this time the two bronze doors for the West Entrance of the U. S. Capitol, designed and modeled by Professor Louis Amateis, of Washington, were cast in New York. In the Science panel of one of the doors is a medallion of Newcomb. At present the doors are in the north vestibule of the National Museum, new building.

Died at Washington, D. C., July 11, 1909

R. C. ARCHIBALD

THE BIOLOGY OF THE MALAYAN ISLANDS[1]

THERE are not many biologists who have not read with absorbing interest, the account by Wallace of his experiences in the Malayan countries, and his conclusions therefrom. Likewise, there are but few biologists unfamiliar with the story of Beccari's experiences in Borneo, or with the account of d'Albertis's expedition to the Fly River. Probably no similar area of land surface has ever yielded, on superficial examination, such a wealth of unique living organisms and striking biological problems. We have reason to know that all of the early work in these regions has been in the nature of pioneer reconnaisance—the breaking of trails—and that the field as a whole is to-day as near a virgin field as any remaining on earth.

It is doubtful if the geography of any other similarly extensive region of earth is so unfamiliar to Americans as that of the Malay Peninsula Region, and the Malay Archipelago. When we speak of the Sunda Group, the Moluccas, or even the large and important Islands of Celebes, Gilolo, Ceram, or Bouru, Americans commonly have but dim idea of their location. And how many Americans know the difference between Macassar and Malacca, or Sulu and Sula? Yet this whole region, including the Philippines, extends from 2 degrees north to 10 degrees south, for a distance of some 2,300 miles, and more than 2,000 miles from east to west. Its northernmost limit falls in the latitude of Mexico City, Santiago de Cuba and Bombay. Its southernmost limit falls in the latitude of Central

[1] Letter addressed to Dr. David Starr Jordan.

Peru and the northern extension of Australia. Some of its most important islands and groups represent very large extents of land surface. Indeed, the whole region, taken together, is considerably more than a fourth of the entire area of the United States. Sumatra is larger than Kansas and Nebraska together by some 20,000 square miles. Borneo is about as large as California and the New England states together. Celebes is twice the size of Illinois. Ceram is larger than the entire Hawaiian group taken together. The magnificent Island of New Guinea is larger than Texas and Louisiana together, and vastly more varied in topography and conditions than either of these states. The great Philippine group of above a thousand islands, comprises a land area of more than 127,000 square miles, scattered through 15 degrees of latitude.

A large part of this entire area is covered with dense tropical forests, but there are also considerable areas of mangrove swamps, upland meadows, and partially arid districts, the whole threaded with numerous streams and with occasional lakes. As a general thing, these countries are very mountainous, many of the mountains reaching into high altitudes, and carrying faunæ and floræ of extraordinary interest. In New Guinea some of the mountains are snow-capped. Extensive evidences of volcanic action, both ancient and recent, are commonly visible, though extensive outcrops of metamorphic rocks occur in most of the groups.

Many of the most interesting of the islands of this region are, biologically speaking, practically terræ incognitæ, having been touched, if at all, only at isolated points, by travelers or expeditions. It is a common experience in the Philippines—even after fifteen years of American occupation—to find important groups of living organisms richly represented, which have never been previously recorded as existing here at all. It is not difficult to enter the more extensive forests at almost any point and stumble upon magnificent forest trees that are wholly unknown to science. The more inconspicuous groups among plants, as for instance the fungi, have been scarcely touched, though, so far as they have been examined, they show a remarkable proportion of new and unique forms. In many groups of insects of the greatest biological and economic importance, we find here a vast fauna, most of the species of which are yet unknown to science. For instance, so far as known to me, only two species of Aphididæ have ever been recorded from the Philippines, and only two species of Thysanoptera, whereas we possess an astonishing display in these two groups. During my first year at Los Baños, I brought together at this one point a far greater number of species of the important family Ichneumonidæ than had previously been described from the entire Malayan region, including Java, Sumatra, the Peninsula, and New Guinea. In three years, at this one point, I have also far exceeded in many universally distributed groups, the number of species reported for entire British India. In certain groups with which I am specially familiar, it is very evident that a knowledge of the Malayan fauna will completely modify our ideas of the comparative anatomy and taxonomy of these groups for the world.

To illustrate what might be very rapidly accomplished here, I may say that during three years, with but scant time myself for field work, but by the use of a Cuban boy whom I have trained for this work through eleven years, and a few Filipino students, I have been enabled to get together very extensive collections of fungi in this locality, which have been occupying a large amount of attention from half a dozen of the world's best mycologists, producing a succession of papers of the highest importance, and making known to science a very large number of remarkable fungus types, including the causative organisms of a very considerable number of important plant diseases. Similarly, these activities—mostly in this immediate locality—in connection with the insects, have produced a mass of valuable materials that is now occupying a large part of the time of above thirty well-known entomological specialists throughout the world. This has been done wholly extra-officially, and at my own personal ex-

pense. If this be possible in so short a time with practically no outside support, what splendid things might not be possible with a little organization and support. After wide experience, running through twenty-four years, I do not, as a general thing, believe in expeditions. The results to be obtained therefrom rarely justify the great expense, and do not compare either in quantity or quality with residence. In these countries we have had resident biologists only in Singapore, Java, Amboina, Sarawak and Luzon—that is, biologists engaged on the fauna and flora. Among other things, continued residence would enable us to make more extensive collections of seeds and living plants than have ever been made in these regions before, and American botanic gardens and American botanists could profit largely through such activities. Recently a single Sunday jaunt made near here produced a fine new *Gardenia*, a new *Pavetta*, several recently described palms, some new Hepaticæ and mosses, and a large number of new fungi.

It seems to me that this is a tremendous opportunity for American institutions or for American scientific societies. I believe that funds for work of this character could be expended here with more highly interesting and important results in proportion to the amount expended, than in almost any of the lesser known regions of the earth. I recommend most strongly that this be accomplished through *residence*, in periods of not less than two or three years for any given region. This would involve something of the nature of a moving laboratory. Good houses can be built very cheaply in these countries, and temporary locations can be obtained with great readiness, and without expense, at almost any point. There are a number of men, including myself, who are ready and anxious to take part in this work, and to whom salary or separation from home and the larger centers are entirely minor considerations. The station or stations maintained would ever be ready as headquarters for students who were engaged in advanced investigations and who might come out for varying lengths of time, assured of finding here a safe and comfortable base for operations in the most favorable regions. There has been a great deal of economic development in these countries since the days of Wallace and Beccari. Steamship lines now reach many points among these islands, and planters have established themselves in many places near the coasts, so that travelling is no longer either difficult or unsafe.

I would suggest that the first station be established in the very large but almost unknown island of Mindanao, the largest of the Philippines, and the interior of which has been rarely even visited by biologists. With an accompanying or succeeding station in British North Borneo, and later in Celebes and the more southern islands, it will be possible to make a more thorough study of island faunæ, as opened up by Wallace, than has ever before been possible in Malayan regions. Results of the highest importance are likely to follow both among plants and insects. A recent collection of Luzon Elateridæ sent by me to Fleutiaux, besides containing many endemic forms, has been shown to include many species formerly supposed to be confined to Borneo, Celebes, Amboina, and even Sumatra. More thorough and comprehensive work promises to completely revise our ideas of the distribution of certain groups through the Malayan Islands. Of even greater importance is the fact that beyond the few highly interesting observations of Wallace and some others, we know nothing of the life relations of the vast series of insects and plants inhabiting this region. This can be tapped effectively only by *residence*. My friend, Mr. Frederick Muir, expert entomologist, of Hawaii, now here with me, who has travelled widely in the Orient, concurs with me, in the belief that the proposed stations would be of the highest possible value in connection with the work in insect parasites which is playing so large a part in the economic entomology of to-day.

It would be necessary to fix some point or points in America as general depositories for the safe preservation and continued study of the materials gathered in connection with this

work. As an initial contribution, I would be glad to deposit now, under certain conditions, some 10,000 herbarium specimens, including cotypes of a large number of new species, and several hundred thousands of specimens of insects, including a large number of types as well as cotypes. Even this contribution alone it would be a pity for America to lose.

I can not, in the limits of a single letter, of this nature, present this matter in all of its more important phases. I believe that it merits your most active interest, and I hope that you will give it the most careful consideration, and then champion it, in so far as it may be possible or feasible for you. Especially, I wish that you would bring it to the attention of any others who would be likely to be interested in the matter, and also, where possible, bring it to the attention of museums, societies, or public institutions, which would be likely to consider taking an active interest in the promotion of this work. I believe that American biology greatly needs the assistance, the light, and the modifying influence that would result from active interest in one of the greatest and most important of the faunæ and floræ of the Orient.

C. F. Baker

Los Baños, Philippines

THE PRESENTATION OF THE JOHN FRITZ MEDAL TO ELIHU THOMSON[1]

It is a pleasure to take part in this tribute of respect to Professor Thomson not merely because of my association with him in the management of the affairs of the Massachusetts Institute of Technology, and the high personal regard that association with such a man entails, but because I realize that he is an educational force of great potency and that it is in the very highest interests of education that his merits should be widely appreciated and at least occasionally acclaimed. In view of what those who have preceded me have said, it must be unnecessary, especially to such an audience as this, to review in detail his remarkable career. All who know anything of the subject know that in the field of electrical engineering his work has been most brilliant and that his contributions to the development of the great science on which so much of our modern conveniences depend will easily bear comparison with those of any man now living. To the public at large this will seem an exaggeration, but the public has little sense of values where such achievements as Professor Thomson's are concerned, and in this case it is handicapped in arriving at the truth through Mr. Thomson's deliberate unwillingness, I might perhaps say his utter incapacity, to advertise himself in the slightest degree.

Much nonsense has been spoken and written about the merits of national expositions, and amongst the statements that might fairly be placed in this class is one to the effect that it was the Paris Exposition of 1878 that *made* Thomson an inventor. It has been forces within Professor Thomson far more than forces outside that have contributed to his great success. He was twenty-five years of age at the time of the Paris Exposition and had already received a sound scientific training and earned distinction in his chosen field. Doubtless his visit to the Exposition stimulated his imagination and gave an incentive to his work, but it can hardly have made him an inventor. Be that as it may, it was not long thereafter that he became a marked man, through his notable contributions to science and its industrial applications. His earliest inventions comprised a comprehensive system for electric arc lighting and I have been told that in those pioneer days his arc-light dynamo was described by a German as "an American machine that violates every known law of the electrical art." This indicates how far Thomson was in advance of his day and on what insecure foundation the electrical art of the time was resting, for the same learned German had to admit that the machine was the most effective and successful dynamo on the market. This was only the beginning of a long series of triumphs that have led, it is said, to over five hundred patents, a large number of them embodying underlying principles so wide in their application that they might almost be classed

[1] Massachusetts Institute of Technology, December 8, 1916.

as physical laws. Amongst his conspicuous achievements is his invention of electric welding about 1880, one of the great inventions of the last generation, and one whose far-reaching importance is not yet fully appreciated. His early lightning arrestors disclosed the magnetic means of blowing out an electric arc which has remained to this day an important feature of many electrical devices. His watt-hour meters are still in use for measuring the current delivered by electric companies to their customers, although the first patents thereon were granted a generation ago. Among his many other notable inventions are his constant-current transformer, his high-frequency transformer, his alternating-current repulsion motor and his automatic regulator for constant-current dynamos.

It is certain, however, that no mere enumeration of inventions suffices as a measure of the man. It does not even suggest the whole story on its strictly scientific side. Many men come to an end of their rope when they have made a specific invention. It is only a few who can correlate a series of inventions into an organized machine that will be effective and economical, and among such men Thomson is transcendant. Apart from this, however, as with all scientists of similar quality, the man is far more than the inventor. It would be an impertinence on my part to give you the full measure of the man, but perhaps I may be permitted in the few minutes that are left to me to touch on one or two aspects of his personality that are indicative of qualities making powerfully for his own success and contributing largely to his stimulating influence on others.

Much has happened in recent years to awaken the world to an appreciation of the fact that industrial improvement and national well-being depend very largely on the progress of science. Consequently, more attention is being given now than ever before to the problems of the schools of applied science. One of the greatest of the problems that confront these schools is the problem of finding adequate means of encouraging the spirit of scientific research. We must, of course, do this through our teachers and the fundamental problem is to find and to attract men who combine two rare qualities, first, the power of extending the boundaries of knowledge and, second, the power of stimulating others to equally effective endeavor. Thomson, had he continued in the schools, would have made the ideal teacher in this respect. He did not so remain, but it is fitting, I think, that people still insist on calling him "Professor." This is a reminder of the fact that he has been and is a great teacher in the sense that I have indicated, although happily his influence has not been confined to any single school. Throughout his life he has not only done great things himself, but shown an intense desire to help all who are struggling earnestly with a scientific problem. He has proved an inspiration to an ever widening circle of engineers and others who have entrusted him with their secrets and sought his help in overcoming their difficulties. They have done this knowing that they had only to ask in order to get the full benefit of his imagination and his power, and that they need have no misgivings that he would take any advantage of their confidence or any credit for their work, for he has no touch of selfishness. That is a great and rare thing in itself, but, of course, there are many other factors that have contributed to the making of the man. Perhaps not the least of these has been his all-roundedness as a man of science. In these days of increasing specialization men's vision is often narrower rather than wider as they advance in years. Thomson so far as his interests are concerned has taken the whole field of scientific development for his parish, not, of course, that he cultivated the whole field; but he has an intelligent interest in and an extraordinarily wide knowledge of what is going on in almost every portion of that field. Doubtless, this has helped him tremendously even in the narrowest region of a particular specialty. Another great aid to his success has been his thorough appreciation of scientific method. There has never been anything haphazard about his processes, although those that do not understand have sometimes said that men like Thomson do things "by instinct." What this really means is that such

men have thought so long and so effectively on the problems in which they are interested and have observed so accurately that an understanding of the fundamental phenomena has become part of their very being. Their instinct is like the instinct of an experienced helmsman, the result of long training and practise. It has sometimes seemed to me that not the least significant fact in regard to Professor Thomson's work is the fact, known to those who have had the pleasure of seeing him in his home, that his laboratory is built right into the home and is an integral part of it. Probably thoughts on scientific problems are never wholly absent from his mind, although he may be consciously thinking of quite other matters. It can hardly be necessary to say that a man who has achieved what Thomson has done must be more than I have pictured, an unselfish, generous, well-trained, well-rounded, well-balanced man of science. Above all and pervading all must be imagination, not necessarily the imagination of a poet, but something akin to that in quality and in power, and it is of course mainly because Thomson is a man of imagination in the highest sense that he has achieved so much success and earned so much respect not only in this country, but throughout the scientific world. He has been literally showered with honors and it must be almost a unique thing to obtain two great national medals within almost a week, one from the Royal Society of London, and the other the great honor of the Fritz medal that is now to be awarded. I heartily congratulate the board of award on having found a man worthy to be placed beside the greatest whose names have already given distinction to their selections, like Graham Bell, Edison and Kelvin. Such a one undoubtedly is Elihu Thomson. Long may he be preserved to us.

RICHARD C. MACLAURIN

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

THE CONVOCATION-WEEK MEETINGS OF SCIENTIFIC SOCIETIES

THE American Association for the Advancement of Science and the national scientific societies named below will meet at New York City, during convocation week, beginning on Tuesday, December 26, 1916:

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.—President, Charles R. Van Hise, president of the University of Wisconsin; retiring president, Dr. W. W. Campbell, director of the Lick Observatory; permanent secretary, Dr. L. O. Howard, Smithsonian Institution, Washington, D. C.; general secretary, Professor W. E. Henderson, Ohio State University; secretary of the council, Dr. C. Stuart Gager, Brooklyn Botanical Garden.

Section A—Mathematics and Astronomy.—Vice-president, Professor L. P. Eisenhart, Princeton University; secretary, F. R. Moulton, University of Chicago, Chicago, Ill.

Section B—Physics.—Vice-president, Professor H. A. Bumstead, Yale University; secretary, Dr. W. J. Humphreys, U. S. Weather Bureau, Washington, D. C.

Section C—Chemistry.—Vice-president, Professor Julius Stieglitz, University of Chicago; secretary, Dr. John Johnston, Geophysical Laboratory, Washington, D. C.

Section D—Mechanical Science and Engineering.—Vice-president, Dr. H. M. Howe, Columbia University; secretary, Professor Arthur H. Blanchard, Columbia University, New York City.

Section E—Geology and Geography.—Vice-president, Professor R. D. Salisbury, University of Chicago; secretary, Professor George F. Kay, University of Iowa.

Section F—Zoology.—Vice-president, Professor G. H. Parker, Harvard University; secretary, Professor Herbert V. Neal, Tufts College, Mass.

Section G—Botany.—Vice-president, Dr. C. Stuart Gager, Brooklyn Botanical Garden; secretary, Dr. A. F. Blakeslee, Cold Spring Harbor, N. Y.

Section H—Anthropology and Psychology.—Vice-president, Dr. F. W. Hodge, Bureau of American Ethnology; secretary, Professor George Grant MacCurdy, Yale University, New Haven, Conn.

Section I—Social and Economic Science.—Vice-president, Louis F. Dublin, Metropolitan Life Insurance Company; secretary, Seymour C. Loomis, 69 Church Street, New Haven, Conn.

Section K—Physiology and Experimental Medicine.—Vice-president, Professor Edwin O. Jordan, University of Chicago; secretary, Professor C.-E. A. Winslow, Yale University.

Section L—Education.—Vice-president, Dr. L. P. Ayres, The Russell Sage Foundation; secretary, Dr. Stuart A. Courtis, Detroit, Mich.

Section M—Agriculture.—Vice-president, Dr. W. H. Jordan, director of the New York Agricultural Experiment Station; secretary, Dr. E. W. Allen, U. S. Department of Agriculture, Washington, D. C.

AMERICAN MATHEMATICAL SOCIETY.—December 27 and 28. President, Professor Ernest W. Brown, Yale University; secretary, Professor F. N. Cole, 501 West 116th St., New York, N. Y.

MATHEMATICAL ASSOCIATION OF AMERICA.—December 28, 29 and 30. President, Professor E. R. Hedrick, University of Missouri; secretary, W. D. Cairns, 5465 Greenwood Ave., Chicago, Ill.

AMERICAN ASTRONOMICAL SOCIETY.—December 26 to 30. President, Dr. E. C. Pickering, Harvard College Observatory; secretary, Dr. Philip Fox, Dearborn Observatory, Evanston, Ill.

AMERICAN FEDERATION OF TEACHERS OF THE MATHEMATICAL AND THE NATURAL SCIENCES.—Council meeting. Secretary, W. A. Hedrick, Central High School, Washington, D. C.

AMERICAN PHYSICAL SOCIETY.—December 26 to 30. President, Professor R. A. Millikan, University of Chicago; secretary, Professor Alfred D. Cole, Ohio State University, Columbus, Ohio.

OPTICAL SOCIETY OF AMERICA.—December 28. President, Dr. Perley G. Nutting, 3 Kodak Park, Rochester, N. Y.

AMERICAN CHEMICAL SOCIETY.—President, Dr. Charles H. Herty, New York City; secretary, Dr. C. L. Parsons, U. S. Bureau of Mines, Washington, D. C.

AMERICAN ELECTROCHEMICAL SOCIETY.—Chairman, New York Section, Dr. Colin G. Fink, Edison Lamp Works, Harrison, N. J.

SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION.—President, Professor H. S. Jacoby, Columbia University; secretary, Professor F. L. Bishop, University of Pittsburgh, Pittsburgh, Pa.

ILLUMINATING ENGINEERING SOCIETY.—President, W. J. Serrill; chairman, Committee on Reciprocal Relations, Clarence L. Law, Irving Place and 15th St., New York, N. Y.

ASSOCIATION OF AMERICAN GEOGRAPHERS.—December 28 to 30. President, Dr. Mark Jefferson, Michigan State Normal College, Ypsilanti, Mich.; secretary, Professor Isaiah Bowman, Yale University, New Haven, Conn.

AMERICAN ALPINE CLUB.—December 30. President, H. G. Bryant; secretary, Howard Palmer, New London, Conn.

AMERICAN SOCIETY OF NATURALISTS.—December 29. President, Dr. Raymond Pearl, Maine Agricultural Experiment Station; secretary, Professor Bradley M. Davis, University of Pennsylvania, Philadelphia, Pa.

AMERICAN SOCIETY OF ZOOLOGISTS.—December 27, 28 and 29. President, Professor D. H. Tennent, Bryn Mawr College; secretary, Professor Caswell Grave, Johns Hopkins University, Baltimore, Md.

ENTOMOLOGICAL SOCIETY OF AMERICA.—December 26 and 27. President, Dr. E. P. Felt; secretary, J. M. Aldrich, West Lafayette, Ind.

AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS.—December 28, 29 and 30. President, Dr. C. Gordon Hewitt, Department of Agriculture, Ottawa, Canada; secretary, Albert F. Burgess, Melrose Highlands, Mass.

AMERICAN GENETIC ASSOCIATION.—December 26, 27 and 28. President, David Fairchild, U. S. Department of Agriculture; secretary, George M. Rommel, 511 11th St., Washington, D. C.

EUGENICS RESEARCH ASSOCIATION.—President, Professor Adolf Meyer, The Johns Hopkins University; secretary, William F. Blades, 191 Haven Ave., New York, N. Y.

ECOLOGICAL SOCIETY OF AMERICA.—December 27, 28 and 29. President, Professor V. E. Shelford, University of Illinois; secretary, Forrest Shreve, Desert Botanical Laboratory, Tucson, Ariz.

BOTANICAL SOCIETY OF AMERICA.—December 27 to 30. President, Professor R. A. Harper, Columbia University; secretary, Dr. H. H. Bartlett, University of Michigan, Ann Arbor, Mich.

AMERICAN PHYTOPATHOLOGICAL SOCIETY.—December 27 to 30. President, Dr. Erwin F. Smith, U. S. Department of Agriculture; secretary, Dr. C. L. Shear, U. S. Department of Agriculture, Washington, D. C.

AMERICAN FERN SOCIETY.—December 29. President, Dr. C. H. Bissell, Michigan Agricultural College; secretary, C. A. Weatherby, 920 Main St., East Hartford, Conn.

SULLIVANT MOSS SOCIETY.—December 29. President, Mrs. Elizabeth G. Britton, N. Y. Botanical Garden; secretary, Edward B. Chamberlain, 18 West 89th St., New York, N. Y.

SOCIETY OF HORTICULTURAL SCIENCE.—December 28, 29. Secretary, C. P. Close, U. S. Department of Agriculture, Washington, D. C.

ASSOCIATION OF OFFICIAL SEED ANALYSTS.—Will meet on dates to be announced. Secretary, John P. Helyar, New Brunswick, N. J.

SOCIETY OF AMERICAN FORESTERS.—Meets on Friday, December 29. President, Dr. B. E. Fernow, University of Toronto; secretary, C. R. Tillotson, U. S. Forest Service, Washington, D. C.

MID-WEST FORESTRY ASSOCIATION.—President, Fred W. Smith, State School of Forestry, Bottineau, N. Dak.

AMERICAN MICROSCOPICAL SOCIETY.—Business sessions. President, Professor M. F. Guyer, University of Wisconsin; secretary, Professor T. W. Galloway, Beloit College, Beloit, Wis.

AMERICAN ANTHROPOLOGICAL ASSOCIATION.—December 26 to 29. President, Dr. F. W. Hodge, Bureau of American Ethnology; secretary, Professor George G. MacCurdy, Yale University Museum, New Haven, Conn.

AMERICAN FOLK-LORE SOCIETY.—December 27. President, Dr. R. H. Lowie, American Museum of Natural History; secretary, Charles Peabody, Harvard University, Cambridge, Mass.

AMERICAN PSYCHOLOGICAL ASSOCIATION.—December 27 to 30. President, Professor Raymond Dodge, Wesleyan University; secretary, Professor R. M. Ogden, Cornell University, Ithaca, N. Y.

AMERICAN PHILOSOPHICAL ASSOCIATION.—December 27, 28 and 29. President, Professor A. O. Lovejoy, The Johns Hopkins University; secretary, Professor E. G. Spaulding, Princeton University, Princeton, N. J.

AMERICAN SOCIETY OF BACTERIOLOGISTS.—December 29. Secretary, A. P. Hitchens, Glen Olden, Pa.

AMERICAN ASSOCIATION OF ANATOMISTS.—December 27, 28 and 29. President, Dr. H. H. Donaldson, Wistar Institute of Anatomy; secretary, Professor C. R. Stockard, Cornell Medical School, New York, N. Y.

AMERICAN PHYSIOLOGICAL SOCIETY.—December 27, 28, 29 and 30. President, Professor W. B. Cannon, Harvard Medical School; secretary, Professor Charles W. Greene, University of Missouri, Columbia, Mo.

AMERICAN SOCIETY OF BIOLOGICAL CHEMISTS.—December 27, 28 and 29. President, Professor Walter Jones, The Johns Hopkins University; secretary, Dr. Stanley R. Benedict, Cornell Medical College, New York, N. Y.

AMERICAN SOCIETY FOR PHARMACOLOGY AND EXPERIMENTAL THERAPEUTICS.—December 28, 29 and 30. President, Professor Reid Hunt, Harvard Medical School; secretary, Dr. John Auer, Rockefeller Institute, New York, N. Y.

AMERICAN SOCIETY FOR EXPERIMENTAL PATHOLOGY.—December 28, 29 and 30. President, Simon Flexner, The Rockefeller Institute; secretary, Dr. Peyton Rous, Rockefeller Institute, New York, N. Y.

(*The above four societies compose the Federation of American Societies for Experimental Biology. Executive Secretary, Dr. Peyton Rous.*)

AMERICAN NATURE-STUDY SOCIETY.—December 27. President, Professor L. H. Bailey, Ithaca, N. Y.; secretary, E. R. Downing, University of Chicago, Chicago, Ill.

SCHOOL GARDEN ASSOCIATION OF AMERICA.—December 29 and 30. President, Van Evrie Kilpatrick, 124 West 30th St., New York, N. Y.

GAMMA ALPHA GRADUATES SCIENTIFIC FRATERNITY.—Will meet on dates to be announced. President, Professor W. J. Meek, University of Wisconsin; recorder, L. C. Johnson, 2018 Madison St., Madison, Wis.

SOCIETY OF THE SIGMA XI.—December 27. President, Dr. Charles S. Howe, Case School of Applied Science; secretary, Professor Henry B. Ward, University of Illinois, Urbana, Ill.

AMERICAN ASSOCIATION OF UNIVERSITY PROFESSORS.—December 29 and 30. President, Dr. John H. Wigmore, Northwestern University; secretary, Dr. H. W. Tyler, Massachusetts Institute of Technology.

MEETINGS OF SECTIONS OF THE AMERICAN ASSOCIATION

As already announced, there will be a symposium "On the Structure of Matter" in a joint meeting of Sections B and C of the American Association for the Advancement of Science, the American Chemical Society, and the American Physical Society, on Wednesday, December 27, 10 A.M. and 2 P.M., in Room 309, Havemeyer Hall, Columbia University. The topics and speakers, arranged for to date, follow:

"Radiation and Atomic Structure," by Robt. A. Millikan. (The address of the president of the American Physical Society.)

"The Atom and Chemical Valence," by Gilbert N. Lewis. Address of the chairman of the section.

"Molecular Resonance and Atomic Structure," by Robt. W. Wood.

"The Relations of Magnetism to the Structure of the Atom," by Wm. J. Humphreys.

"The Relations of Magnetism to Molecular Structure," by Albert P. Wills.

"The Evolution of the Elements as Related to the Structure of the Nuclei of Atoms," by Wm. D. Harkins.

"Electromerism, a Case of Chemical Isomerism Resulting from a Difference in Distribution of Valence Electrons," by Lauder W. Jones.

It is planned to secure speakers to open the discussion; but, as the whole day is to be devoted to this question, it is hoped that others will come prepared to contribute.

The program of meetings of Section D—Engineering—for the New York meeting is as follows:

10.00 A.M., Thursday, December 28, Room 402 Engineering Building, Columbia University. Session for presentation of research papers in various fields of engineering. Presiding officer, Dr. Henry M. Howe.

2.00 P.M., Thursday, December 28, Assembly Hall, Automobile Club of America, 247 West 54th Street. Joint session of Section D with Society for the Promotion of Engineering Education, the National Highways Association, the National Automobile Chamber of Commerce, and the Automobile Club of America. Subject: "Highway Engineering Instruction in Civil Engineering Curricula." Presiding officer, Dr. Hollis Godfrey, first vice-president, Society for the Promotion of Engineering Education.

8.00 P.M., Thursday, December 28, Assembly Hall, Automobile Club of America. Joint session of Section D with the National Highways Association, Citizens' Street Traffic Committee of Greater New York, and the Automobile Club of America. Subject: "Research Papers in Highway Engineering." Presiding officer, Dr. Henry M. Howe.

8.30 P.M., Friday, December 29. Auditorium, United Engineering Societies Building, 29 West 39th Street. Joint session of Section D with the American Society of Civil Engineers, American Society of Mechanical Engineers, American Institute of Electrical Engineers and American Institute of Mining Engineers. Presiding officer, Dr. Henry M. Howe, introduced by the president of the Engineering Foundation, Dr. Gano Dunn. Address by retiring vice-president, Dr. Bion J. Arnold. Addresses by representatives of the National Engineering Societies re Interrelationship of Engineering and Pure Science. Meeting to be followed by a reception tendered to the American Association for the Advancement of Science by the National Engineering Societies.

Section G—Botany—will hold a joint meeting with the Botanical Society of America and the American Phytopathological Society in the auditorium of Horace Mann School, Broadway and 120th Street, on Wednesday, December 27, at 2:00 P.M., when the program will be as follows:

"Geographical Distribution of the Marine Algæ" (vice-presidential address), by W. A. Setchell.

Symposium on Relations of Chemistry to Botany:

"The Service of Chemistry to Botany," by C. L. Alsberg. (Discussion introduced by H. M. Richards.)

"Antagonism and Permeability," by W. J. V. Osterhout. (Discussion introduced by H. M. Benedict.)

"Physical Chemistry in the Service of Phytogeography," by J. A. Harris. (Discussion introduced by B. E. Livingston.)

The symposium will be followed by a short business meeting of Section G. The members of Sections G and F are invited by the New York Zoological Society to a reception and smoker to be held at the New York Aquarium, Battery Park, Wednesday evening, December 27.

Section L—Education—will hold its meetings at Teachers College, on December 27, 28 and 29. The program of fifty papers dealing with the scientific study of educational problems in many different fields of school work should prove attractive to superintendents, teachers and students of education. Many persons well known for their educational work will contribute to the program. Professor E. L. Thorndike will discuss "The Reliability of Certain Educational Tests"; Dr. Abraham Flexner, of the General Education Board, will speak on the work of the board; Frank G. Gilbreth and Lillian Moller Gilbreth, leaders in the application of micro-motion study to

problems of industrial education will report the effect of auto micro-motion study on educational methods in teaching typewriting and manual training; Professor Earl Clarke, of the Russell Sage Foundation, will present a paper on "The Relationship between the Indebtedness of City School Systems and Current Expenditures for the Operation and Maintenance of Schools." The names of Goddard, Rapeer, Heck, Trabue, Meriam, Mead, Kelly and many others well known for their contributions to current educational literature and methods, serve to indicate that those attending the meetings of Section L will be well repaid for their trouble. Sessions of the section will be held each morning and afternoon on Wednesday, Thursday and Friday. The Friday morning session will be a joint meeting with the American Psychological Association. The address of the retiring vice-president, Elwood P. Cubberley, of Leland Stanford Junior University, will be on Thursday afternoon.

SCIENTIFIC NOTES AND NEWS

MEMBERS of the American Association for the Advancement of Science whose dues are paid later than January 1, will receive the back numbers of SCIENCE only on payment of one cent a number to cover the extra cost of mailing. It can not be guaranteed that the copies will be supplied, as, owing to the extraordinary increase in the cost of paper, only so many extra copies will be provided as are likely to be needed. The offices of the permanent secretary of the association and of SCIENCE will be greatly assisted by the prompt payment of dues.

DR. HUGO MÜNSTERBERG, distinguished psychologist and author, professor of psychology and director of the psychological laboratory of Harvard University, died suddenly while lecturing to a class on December 16. Professor Münsterberg was born in Danzig in 1863 and was called from Freiburg to Harvard University in 1892.

THE public lectures of the approaching meeting of the American Association for the Advancement of Science will be given by Dr. Simon Flexner, director of the laboratories of the Rockefeller Institute for Medical Research, and by Dr. A. A. Noyes, professor of physical chemistry at the Massachusetts Institute of Technology. Dr. Flexner's lecture on "Infantile Paralysis and the Public Health" will be given at Columbia University at five o'clock on the afternoon of Thursday, December 28. Professor Noyes's lecture on "Nitrogen and Preparedness," will be given on the evening of the same day at the American Museum of Natural History.

MR. THEODORE ROOSEVELT will make the principal address at the opening of the New York State Museum at Albany on the evening of December 29, his subject being "Productive Scientific Scholarship." Among those who will make addresses at the afternoon exercises are Dr. John H. Finley, president of the University of the State of New York; Dr. Charles D. Walcott, secretary of the Smithsonian Institution, and Dr. John M. Clarke, director of the State Museum.

THE Bruce gold medal of the Astronomical Society of the Pacific for the year 1917 has been awarded to Professor E. E. Barnard, of the Yerkes Observatory, for his distinguished services to astronomy. The formal presentation will take place at the annual meeting of the society at San Francisco, on the evening of January 27. This is the fourteenth award of the medal.

THE 1917 meeting of the Pacific Division of the American Association for the Advancement of Science will be held at Stanford University, California, between the dates of April 4 and 7. It is anticipated that Thursday and Friday, April 5 and 6, will become the principal days for meetings of the several Pacific coast societies which will participate in this occasion. Further announcements concerning the meetings, railroad rates and excursions will be made later.

FIFTEEN members of the American Association for the Advancement of Science residing in the city of Rochester, N. Y., held a meeting recently and organized the Rochester Branch of the association. The executive committee consists of H. L. Fairchild, *chair-*

man; H. A. Carpenter, *secretary;* C. C. Hopkins, Adolph Lomb and C. E. Kenneth Mees. The association now has about forty members in the city and the number is increasing. It is not the intention of the Rochester Branch to compete in any manner with the numerous scientific societies in the city, but it aims to do locally what the association is doing in the national field; that is, to stimulate general interest in scientific study, to secure more scientific operation of the city housekeeping, and to act as the correlating body for greater union and effectiveness of the scientific forces in the city, which has a remarkable development of applied science.

At the annual election of the New York Academy of Medicine on December 7, the following officers were elected: President, Dr. Walter B. James; vice-president, Dr. Edwin B. Cragin; trustee, Dr. Charles L. Dana; member of committee on admissions, Dr. Samuel A. Brown, and member of committee on library, Dr. Warren Coleman.

At the seventy-first annual meeting of the Smithsonian Institution held in Washington on December 14 the resignation of Dr. Andrew D. White as a regent was presented and accepted, the board adopting a resolution of appreciation of his nearly thirty years of service. Dr. White wrote that with advancing age he found it impossible to attend to the duties. Representative James T. Lloyd, of Missouri, was appointed to succeed Maurice Connolly, of Iowa, whose Congressional term had expired.

The five members of the International Health Board Commission of the Rockefeller Foundation, which left June 15 for South and Central America to study yellow fever and other contagious tropical diseases, have returned to the United States. The commission was headed by Major-General William C. Gorgas, U. S. A., and included Dr. Henry R. Carter, of the United States Public Health Service; Dr. C. C. Lyster, Dr. Eugene R. Whitmore, Dr. William R. Wrightson and Dr. Juan Guiteras, head of the Public Health Service of Cuba. Dr. Guiteras stopped at Barbados to investigate reported yellow-fever conditions there. General Gorgas said that the members of the commission had a very successful trip, and that details of their investigations and their recommendations would be made public through the Rockefeller Foundation.

Dr. Waldon E. Muns, formerly of Bellevue Hospital laboratory, New York, has been appointed first assistant bacteriologist in the Syracuse city laboratory, succeeding Dr. William L. Culpepper, who resigned to accept a position with the International Health Board of the Rockefeller Foundation.

Dr. Rudolf Rubrecht, for several years research chemist in the chemical laboratory of the Massachusetts Agricultural Experiment Station, has resigned to accept an industrial position in Philadelphia.

Arrangements have been completed by the American Museum of Natural History for an exhibit of some of Charles R. Knight's recent paintings and small bronzes of modern animals and also of a mural decoration of prehistoric animals in the West Assembly Hall of the Museum from December 15, 1916, to January 15, 1917.

Dr. William W. Keen (Brown, '57), emeritus professor of surgery at Jefferson Medical College, will deliver three lectures on January 10, 15 and 17 on the Colver Foundation of Brown University, taking as his subject: "Medical Research and Human Welfare." The lectures will be "the record of personal experience and observation during a professional life of fifty-seven years."

Professor Mary W. Calkins, of Wellesley College, is this year the lecturer in philosophy on the Mills Foundation at the University of California. Her subject is "The Fundamental Problems of Philosophy."

The first lecture in the Adolfo Stahl Lecture Course in Astronomy was given in San Francisco, on the evening of November 10, 1916, by Dr. W. W. Campbell, on the subject "The Solar System." The course is given under the auspices of the Astronomical Society of the Pacific, and provision for it was made by

Mr. Adolfo Stahl, a public-spirited citizen. The course will include five additional lectures, all free to the public, as follows:

December 8, 1916, "Comets," W. W. Campbell.

January 12, 1917, "A Total Eclipse of the Sun," R. G. Aitken.

February 9, 1917, "Double Stars and Star Clusters," R. G. Aitken.

March 9, 1917, "The Nebulæ," H. D. Curtis.

April 6, 1917, "How Astronomical Discoveries are Made," H. D. Curtis.

PROFESSOR HENRY MELVILL GWATKIN, Dixie professor of ecclesiastical history in the University of Cambridge, England, died in November. He was known as a specialist in Mollusca, and his collection of Molluscan radulæ was doubtless the largest in existence. It is understood that this collection now goes to the British Museum.

PROFESSOR J. H. MERIVALE, formerly of Armstrong College, Newcastle, since engaged in mining engineering, died on November 18 at the age of sixty-five years.

LIEUTENANT CORIN H. B. COOPER, R.E., for a time demonstrator in geology at McGill University, and later engaged on government survey work in the oilfields of the Rocky Mountains, has been killed in the war.

THE directors of the Fenger Memorial Fund announce that the sum of $500 has been set aside for investigation in medicine or surgery in 1917. The money will be used to pay all or part of the salary of a worker, the work to be done under direction in an established institution, which will furnish the necessary facilities and supplies free of cost. It is desirable that the work undertaken should have a direct clinical bearing. Applications giving full particulars should be sent to Dr. L. Hektoen, 629 S. Wood St., Chicago, before January 15, 1917.

THE Naples Table Association for Promoting Laboratory Research by Women announces the offer of the Ellen Richards Research Prize of $1,000 for the best thesis written by a woman embodying new observations and new conclusions based on independent laboratory research in biology (including psychology), chemistry or physics. Theses offered in competition must be in the hands of the chairman of the committee on the prize before February 25, 1917. Application blanks may be obtained from the secretary, Mrs. Ada Wing Mead, 283 Wayland Avenue, Providence, R. I.

THE Sarah Berliner Research Fellowship for Women of the value of $1,000 is offered annually, available for study and research in physics, chemistry or biology. Applicants must already hold the degree of doctor of philosophy or be similarly equipped for the work of further research. Applications must be received by the first of February of each year. Further information may be obtained from the chairman of the committee, Mrs. Christine Ladd-Franklin, 527 Cathedral Parkway, New York.

FORTY-SEVEN students who recently passed final examinations of the Faculty of Medicine, University of Toronto, have enlisted for service in the medical corps, and will leave in the immediate future for overseas service. A special convocation was held on the evening of November 28 in Grant Hall, Queen's University, Kingston, Ont., at which sixty-three medical graduates were granted their degrees. All these graduates will go overseas shortly to serve at the front.

LEGISLATION has recently been enacted which will provide for approximately 300 additional medical officers in the Medical Corps of the United States Navy. The pay ranges from $2,000 per year, with quarters or an allowance therefore, for assistant surgeons with the rank of lieutenant, junior grade, to $8,000 with allowances upon attaining the grade of medical director with the rank of read admiral of the upper half. Applicants must be between the ages of 21 and 32 years, citizens of the United States, and must submit satisfactory evidence of preliminary and medical education. The examination for appointment in the medical corps consists of two stages, the first stage securing appointment in the Medical Reserve Corps, and the second stage securing an appointment as a commissioned officer in the regular medical corps. After the candidate passes the preliminary examination he attends

a course of instruction at the Naval Medical School. During this course he receives full pay and allowances of his rank, and at the end of the course he takes a final examination. Two of these courses begin each year, one commencing about the first of October, and the second course beginning early in February. The examinations are held in several of the coast cities in the United States, both on the east coast and the west coast, and also at Chicago, Ill. Literature describing the navy as a special field for medical work, and circulars of information for persons desiring to enter the medical corps, may be obtained by addressing the Surgeon General, U. S. Navy, Navy Department, Washington, D. C.

UNIVERSITY AND EDUCATIONAL NEWS

By the will of Mrs. Mary W. Harkness, widow of Charles W. Harkness, about $1,100,000 is bequeathed to public purposes. The largest bequest is $300,000 to Yale University, the income to be used in the payment of salaries of officers of instruction.

Boston University has received an anonymous gift of $100,000 for scholarships for young men in the college. The gift is made in honor of Augustus Howe Buck, emeritus professor of Greek.

Professor and Mrs. William A. Herdman, of the University of Liverpool, have given to the university the sum of £10,000 for the endowment of a chair in geology in memory of their son, who was killed in the war.

Paul Sabine, of Harvard University, has been appointed assistant professor of physics at the Case School of Applied Science and will have charge of the physics laboratory.

Dr. A. R. Davis, formerly research assistant at the graduate laboratory, Missouri Botanical Garden (Shaw School of Botany, Washington University), has been appointed assistant professor of botany at the University of Nebraska. Mr. R. A. Studhalter and Mr. H. C. Young, formerly Rufus J. Lackland research fellows in the same institution, have been appointed, respectively, assistant botanist in the Montana Agricultural Experiment Station and instructor in botany in the Michigan Agricultural College. Miss Ruth Beattie has accepted a position as instructor in botany at Wellesley College.

At the University of Sheffield Dr. W. E. S. Turner has been appointed lecturer in charge of the new department of glass technology.

DISCUSSION AND CORRESPONDENCE

PSYCHOLOGY AND MEDICAL EDUCATION

To the Editor of Science: In your issue of November 10, Dr. Cecil K. Drinker has approached the problem of advising students planning to enter the medical profession as to what courses over and above those required they can most profitably give their attention to during their college years. Dr. Drinker has urged the undergraduate to take as much physics and chemistry as possible: I should like to enter a similar plea in favor of psychology.

The importance of a knowledge of psychology to all persons engaged in the practise of medicine is, no doubt, widely recognized by both practitioners and teachers of that science and art to-day, and the value of psychological study as a part of medical education received special attention in a symposium and report on the subject in Science for October 17, 1913. Little has been heard of the matter recently, however, and I feel it can do no harm to bring up the subject again in the hope that real interest may be aroused in pushing it more effectively to the front.

The conclusions of the report referred to clearly enunciate the need of more cooperation than is at present existent between psychologists and—not only psychiatrists, whose concern is primarily with the problems of the diseased mind—but also the physicians of the body. For all schools of psychology to-day acknowledge and even emphasize the inseparableness of mental states and processes from the physiological conditions which underlie or at least invariably accompany them, and medical men are fully aware of the influence which mental states have upon the health of the body.

But I am especially interested here in adding to what was said by Dr. Franz's commitee a word for the subject of *abnormal* psychology in a premedical course. A glance at any of the text-books on mental disorders—such as those of Stoddart or Diefendorf—reveals at once psychological conceptions of the crudest nature. In the medical school, when the student's attention is necessarily directed entirely to the body side of that complex affair called the human individual, it is but natural that a strongly materialistic bias should develop which, if not counterbalanced by a predirected emphasis on the side of the psychical, is certain to issue finally in a complete loss of the necessary scientific equilibrium. The medical school teacher delights in demonstrating to his pupils that the phenomena of insanity are merely symptoms of diseases of the brain and nervous system, which can be explained in purely physiological terms without invoking any non-material influences. Now this may all be true, but certainly it is but fair that the psychologist should be given his opportunity to demonstrate also that those same phenomenon can be fully described, and many of them explained, in purely mental terms without referring to the brain or nervous system at all, and that a purely psychological *description* is in many cases the only really valid and useful one. It would be well, of course, if all psychologists and all physicians were broad-minded enough to appreciate equally the mental and the physiological factors in human life, but this is perhaps too much to expect of any infra-angelic intelligence! Such being the weakness of the human intellect, therefore, we can but recognize it, and seek to overcome the one-sidedness of the physician's outlook by the other-sidedness of the psychologist's viewpoint.

For the reassurance of the physician it may be well to add that, on the principle that "he who laughs last laughs best," no possible harm can be done by accepting the suggestions I urge, as it is the medical school teacher who will have the last shot at the student and thus the better chance of influencing his views for the future. Furthermore I am convinced that a firm preliminary grounding of the student in the principles of the normal *and abnormal* mind as the psychologist studies them can not but be of the greatest positive value to the physician.

JARED S. MOORE
WESTERN RESERVE UNIVERSITY

THE RETENTION OF OIL BY CLAY AT WATERVILLE, MAINE

WHILE attempting to unravel the extent of the post-Pleistocene terrace at Waterville, I had occasion to ask one of the railroad officials, Mr. Thomas Harrold, whether the railroad yards are underlain by clays or the slate ledge which outcrops near by. He informed me that they are underlain by clay and gave the following interesting facts in explanation of his knowledge. In March, 1911, he was superintending the installation of a new set of scales in the Waterville yards. During the excavation for the foundation, clay was encountered a few feet below the surface and a fluid, supposedly water, collected in the hole. Further examination showed this to be kerosene, and about five barrels were removed. The presence of the oil was explained when it was remembered that in 1909 the contents of a tank car had been lost in the yards.

Several years after the events recorded above, in the summer of 1914 or 1915, came a period of unusually heavy precipitation. The water table over the clay rose near the surface and kerosene began to collect in the drainage ditches near the tracks. One man is said to have collected eleven barrels of the kerosene and the adjoining population were so active in digging pits to collect the fluid that the tracks were undermined and the railroad officials found it necessary to prohibit the removal of the oil.

These are the facts as reported to me. I might add that the railroad yards are just to the west of the Kennebec River. The river flows in a slate gorge here, the rock extending to the top of the bank on this side; then comes a flat of 10–15 feet representing the old railroad bed; back of this the ledge is overlain immediately by the fill beneath the present tracks.

The writer has many times noticed the large amount of oil which covers the flat, killing vegetation and sending out a disagreeable bituminous odor. I had always supposed that the oil must represent the concentration from cotton waste, etc., collected there year after year, especially as large car shops are nearby. The true explanation, bringing out as it does the retention of the oil by the clay and the response to ground water conditions, seemed to make a note of the facts worth placing on record.

Homer P. Little

Waterville, Maine

THE RECOGNITION OF ACHIEVEMENT

There are probably a good many successful scientific men in America who will echo in some measure the sentiments expressed by W. E. Allen in a recent issue of Science. There certainly should be some method of distinguishing individuals who have attained eminence in their respective lines irrespective of whether they hold a doctor's degree or not. Even the holder of such degrees may well join in a movement to distinguish the real workers from those who have merely secured degrees. It is clear that the doctor's degree does not necessarily indicate exceptional merit; in fact the degree itself has varying shades of importance. A man who has been educated in a prominent institution is much more inclined to write the name of the university after the degree than he is if his university is less prominent.

To the man with a degree, it may seem absurd for others who are not doctors to suggest a distinguishing mark for meritorious work but if such marks are not desirable, why attach college and university degrees to an individual at all? Is the mere fact that he has gone through a prescribed course in a university to be forever remembered regardless of the quality of his work in after years, or shall we demand that he measure up to his promises when the degree was conferred; in short, is it schooling or achievement that shall count?

As time goes on and doctors continue to increase in numbers, some such distinction as has been suggested will become increasingly desirable. This seems a good time to do something about it.

Willard N. Clute

Joliet, Ill.

CLOUDS

Since the many forms of fog and cloud reveal, as obviously nothing else can, the motions and conditions of the atmosphere, it would seem that their every type must have been the object of innumerable photographic records, and that nothing could be easier than to make a reasonably complete collection of such photographs.

This, however, at least so far as making the collection is concerned, is not the case. Some clouds, such as the mammato-cumuli, the scarf-like wisps that form above thunder heads, the tornado's funnel and several others of somewhat infrequent occurrence appear rarely to be photographed—I have never seen a good photograph of any one of them—while even the more common clouds seem generally to be photographed with inadequate equipment.

To obtain the best photographs of cirri, for instance, that is, to secure such contrast that the finer details may be seen, it is absolutely necessary to use some sort of device by which the maximum amount of polarized sky light may be cut out. Needless to say this is seldom done. Similarly, if one would accentuate the beauty of his cloud picture by including an interesting landscape it is obvious that he must use a suitable ray filter. Finally, as the clouds are drifting, often with considerable velocity, the exposures must be practically instantaneous.

But difficult as photographing clouds may be surely some enthusiasts must have accumulated many fine pictures of them, and I am taking this opportunity of asking if those who have exceptionally fine cloud and fog pictures will not kindly write to me of them, as I am anxious to obtain good examples of every type for the purpose of study and comparison. Of course none would be reproduced without permission and proper acknowledgment.

W. J. Humphreys

U. S. Weather Bureau,
Washington, D. C.

SCIENTIFIC BOOKS

A Text-book of Biology for Students in General, Medical and Technical Courses. By William Martin Smallwood, Professor of Comparative Anatomy, Syracuse University. Philadelphia, Lea and Febiger. 1916. 317 pages, 261 engravings and 10 plates.

If a healthy interest in the method of teaching elementary zoology may be inferred from the number and variety of text-books appearing we may congratulate ourselves upon our present state. It is clear, however, from the varied character of the materials treated, that there is as yet no agreement regarding the matter which should enter into such a course. Since almost every phase of the subject has been presented, through methods of great diversity, it would seem possible that in time the experience of many teachers in widely different surroundings would point to the types of books best suited for elementary instruction. Judging by numbers, the present tendency would seem to be toward some very general treatment to which the term "biology" might be given. Some of these books have been long enough in service to have passed the first edition stage, and of these Smallwood's "Text-book of Biology" is one. This now appears in the "second edition, thoroughly revised and enlarged." A change in the title may be significant of an altered viewpoint of the author. In the first edition it is stated that the book is "for students in medical, technical and general courses" but in the present edition the last is made first and emphasis is placed on "general courses" by their early mention. Specific statement is also made of the importance of breadth of training in the preface, and, although this occurs in a reference to the purpose of the earlier edition, it is evident that the author has come to place additional value upon the underlying general principles of the subject. While he doubtless felt like "leaving their application to the teachers of advanced zoological, botanical and professional courses" at the time of writing the book, he is now strongly enough of the opinion to say so.

It is to be hoped that this is an indication of a general change in attitude toward too much of the "applied" in elementary biological instruction. That the author should be encouraged to announce his position more definitely on this point because of the formulated opinion of teachers of anatomy is very encouraging to all who believe in the value of thorough preparation in general subjects and who rightly feel they should have the support of those who teach the more specific and applied branches.

Such a conception of the relation of general to applied biology does not, however, signify to the author of the text that his subject-matter must be remote from experience or removed from practical interest, as is indicated by Chapter XV., which deals with "some biological factors in disease." Indeed, the length of this chapter in comparison with others—it exceeds the one devoted to "The Plant Kingdom"—and the details of disease symptoms recorded might incline a captious critic to question the emphasis claimed for broad principles. In this attitude he would be strengthened by the criterion adopted for an inclusion of a study of the Pelecypods in the book—this being that "clams and oysters are so generally used as food and so frequently cause disease" (p. 157). But the temptation to popularize our subjects is great, so it is not well, perhaps, to blame the author overmuch for occasional lapses toward the "practical."

There is now little chance in general texts to introduce anything new in the arrangement of the subjects, but Smallwood endeavors to add this touch by emphasizing the historical development of biology in the sequence of chapters. Since this represents the natural approach to the subject and follows the course of improvements in technique and instruments, it can not be far wrong practically. "The earlier chapters (I.–IX.) of this work, accordingly, take him (the student) through a consideration of the organism as a whole, the structure and function of organs, the structure and properties of tissues, and the parts of the cell and their work. The chapter devoted to the biology of cells furnishes the basis for the modern point of view and acts as a background for the remainder of the book." The topics of

these later chapters are "XI., Biology of Bacteria, Yeast and Moulds; XII., Classification—the 'Worms,' Mollusca and Arthropods; XIII., The Plant Kingdom; XIV., Some Biological Adaptations; XV., Some Biological Factors in Disease; XVI., Evolution; XVII., Variation-heredity; XVIII., Animal Behavior and Its Relation to Mind." From this outline it will be seen that the author maps out a very extensive program and it is not surprising that consideration of many topics is very brief, and, almost necessarily, inadequate many times. An account of "The Plant Kingdom" in 23 pages can not be very satisfying.

The style of the book is readable, but unfortunately is marred by many loose statements and faulty definitions. The cell is stated to be composed of the "nucleus" and "cytoplasm"—a structure and a substance, instead of nucleus and cytosome—structural subdivisions. Many examples of such definitions appear throughout the book. Physiology is defined as "the work that an organism does or the work of its parts"; metamorphosis as "a name given to the life-history of insects, frogs, etc."; symbiosis as "the living together of dissimilar plants or animals or a plant and an animal." The illustrations are good and are properly chosen to represent other forms than the ones used in the laboratory. No laboratory outlines are given and the brief and very general chapter headings, called "Laboratory Studies," would be of no service to a competent teacher and are far too general to help an untrained one. They could properly be omitted.

C. E. McClung

SPECIAL ARTICLES

THE CAUSE OF THE DISAPPEARANCE OF CUMARIN, VANILLIN, PYRIDINE AND QUINOLINE IN THE SOIL

PRELIMINARY NOTE

Considerable attention has been devoted recently to the fact that organic substances which are toxic to higher plants in water culture lose their toxicity when added to the soil.[1] This depends, however, on the soil.[2] This loss of toxicity would seem to be due to the fact that the substances, as such, disappear in the soil.[3] Funchess[4] has also found that many of the organic nitrogenous compounds toxic to plants in water culture are apparently nitrified in the soil. This would point to their disappearance as being due to biological causes. Some observations made by the writer during the past year on the cause of the disappearance of four of these compounds may prove suggestive to those who are investigating this problem.

Cumarin, vanillin, pyridine and quinoline were added separately at a concentration of 1,000 parts per million to soil in pots. This soil was similar to that used by Funchess,[5] in which the organic toxins were found to lose their toxicity or even become beneficial to plant growth. The number of microorganisms developing in the treated pots and in the check pots was determined at intervals over a period of about three months. In each case the numbers of microorganisms increased enormously in the treated pots, after, in some cases, an initial depression in numbers. The phenomenon appeared entirely analogous to that found in partial sterilization.

In order to determine whether microorganisms are concerned in the destruction of the substances named above, the compounds were added to sterile soil in two liter bottles. Part of each set of bottles, treated with one of the four substances mentioned above, was inoculated with an infusion from normal soil. The bottles were incubated about two months at room temperature. At the end of that time sterile wheat grains were planted in the bottles. The growth of the wheat plants showed that in the inoculated soil the toxic properties of the vanillin, cumarin, pyridine and quinoline had largely disappeared, but were still very evident in the bottles containing sterile soil. This seemed to indicate that

[1] Davidson, J., *Jour. Am. Soc. Agr.*, 7: 145–158, 221–238 (1915). Upson, F. W., and Powell, A. R., *Jour. Ind. and Engin. Chem.*, 7: 420–422 (1915). Fraps, G. S., Texas Ag. Ex. Sta. Bul., 174 (1915). Funchess, M. J., Alabama Ag. Ex. Sta. Tech. Bul., 1 (1916).

[2] Skinner, J. J., U. S. Dep't Agr. Bul. 164 (1915).

[3] Fraps, *loc. cit.*

[4] Unpublished data.

[5] *Loc. cit.*

the disappearance of the compounds was chiefly due to biological causes.

From the bottles or pots three species of bacteria were isolated, one of which uses pyridine as a source of nitrogen, one vanillin as a source of carbon and one cumarin as a source of carbon. An organism acting on quinoline has not yet been found.

This would seem to show that the enormous increase in numbers of organisms noted in the treated pots and the disappearance of the four substances in the soil depend on the fact that they (the compounds) serve as food sources to definite species of bacteria.

The significance of these facts to the soil toxin theory of soil fertility is evident. The persistence of vanillin, for example, in some soils and not in others may be due to the fact that the vanillin organism is absent or to the fact that conditions are not suitable for its development or for the use of the vanillin. If we should be able to improve a soil containing vanillin by treating it with the vanillin organism the results should be a strong argument for the soil-toxin theory of soil fertility. This of course is a step into the future.

The results are also suggestive in explaining some of the phenomena accompanying "partial sterilization." They would suggest that in "partial sterilization" (at least that caused by these four compounds) we do not have a large increase in the numbers of microorganisms because the less resistant are killed and the resistant forms given opportunity to develop; or because voracious protozoa are eliminated; but because the sterilizing agent used serves directly[6] as a food source. In the case of steam, and perhaps carbon bisulphide, unavailable food supplies are probably made available.

WILLIAM J. ROBBINS
DEPARTMENT OF BOTANY,
ALABAMA POLYTECHNIC INSTITUTE,
AUBURN, ALABAMA

SOCIETIES AND ACADEMIES

THE AMERICAN PHYSICAL SOCIETY

THE eighty-fifth regular meeting of the American Physical Society was held in the Ryerson Laboratory of the University of Chicago on Saturday, December 2.

The following papers were presented:

"On the Velocity of Sound in Metal Tubes," by Karl K. Darrow, University of Chicago.

"Collapse of Thin Tubes Shorter than the Critical Length," by A. P. Carman, University of Illinois.

"An Acoustical Thermometer," by F. R. Watson and H. T. Booth, University of Illinois.

"A General Method of producing the Stroboscopic Effect, and its Application in the Tonodeik," by L. E. Dodd, State University of Iowa.

"The Intensity-factor in Binaural Localization and an Extension of Weber's Law," by G. W. Stewart and O. Hovda, State University of Iowa.

"An Apparatus for the Demonstration to an Audience of Simple Harmonic Motion," by Paul E. Klopsteg, University of Minnesota.

"Report of Progress on the Measurement of Earth Rigidity," by A. A. Michelson and Henry G. Gale, University of Chicago.

"The Accuracy with which Gravity may be predicted at any Point in the United States," by John F. Hayford, Northwestern University.

"A Proposed New Method for the Determination of the Acceleration due to Gravity," by Herbert Bell, University of Michigan.

"On Some Very Large Variations in the Adsorption of certain specimens of Charcoal," by Harvey B. Lemon, University of Chicago.

"The Principle of Similitude," by C. S. Frazel, University of Illinois.

"Preliminary Notes on the Torsional Elasticity of Drawn Tungsten Wires," by L. P. Sieg, State University of Iowa.

"A Precision Calorimeter for measuring Heats of Dilution," by D. A. MacInnes and J. M. Braham, University of Illinois.

"Note on the Amount of Error in applying to Non-Parallel Plates the Formula for Electrical Capacity of Parallel Plates," by L. E. Dodd, State University of Iowa.

"The Kinetic Theory of Non-Spherical Rigid Molecules," by Yoshio Ishida, University of Chicago.

"The Photo-electric Emission from Crystals of Selenium," by F. C. Brown, State University of Iowa.

"The Production of Light by Cathode Rays in Air," by Gordon S. Fulcher, University of Wisconsin.

"The Optical Constants of Liquid Alloys," by Carleton V. Kent, University of Michigan.

"The Single-lined and the Many-lined Spec-

[6] This has been suggested for pyridine. See Buddin, W., *Jour. Agr. Sci.*, 6, 416–451 (1914).

trum of Mercury," by T. C. Hebb, University of Chicago.

"Note on the Single-lined and the Many-lined Spectrum of Mercury," by R. A. Millikan, University of Chicago.

"The Structure of the Bismuth Line at Wavelength 4722," by Henry G. Gale and Lester Aronberg, University of Chicago.

"Visual Diffusivity," by Herbert E. Ives, United Gas Improvement Co., Philadelphia.

"Measurement of Wave-lengths with the X-ray Spectrometer," by Elmer Dershem, State University of Iowa.

"A Single Bar and Yoke Method for the Magnetic Testing of Iron Bars," by Arthur Whitmore Smith, University of Michigan.

"Some Effects of Cross-Magnetizing Fields on Hysteresis," by N. H. Williams, University of Michigan.

"A. C. and D. C. Corona in Hydrogen," by John W. Davis, University of Illinois.

"The Magnetic Properties of Fe, Ni and Co above the Curie Point, and Keesom's Theory of Magnetization," by Earle M. Terry, University of Wisconsin.

"A Simple Method for determining the Audibility Current of a Telephone Receiver," by Edward W. Washburn, University of Illinois.

"An Extension of the Mayer Experiments," by R. R. Ramsey, Indiana University.

"The Derivation of the Retarded Potentials," by Max Mason, University of Wisconsin.

"The Mass of the Electric Carrier in Copper, Silver and Aluminium," by Richard C. Tolman and T. Dale Stewart, University of Illinois.

"An Experimental and Theoretical Investigation of Binaural Beats," by G. W. Stewart, State University of Iowa.

"Contact Electro-motive Forces and the Energy of Emission of Electrons under the Influence of Monochromatic Light," by R. A. Millikan, University of Chicago.

"The Permanence of the Wave-length Sensibility Characteristics of Photo-electric Cells," by Herbert E. Ives, United Gas Improvement Co., Philadelphia.

"An Effect of Light on the Contact Potential of Selenium and Cuprous Oxide," by E. H. Kennard and E. O. Dieterich, University of Minnesota.

"A Peculiar Gas-Crystal Resistance Change in Selenium," by W. E. Tisdale, State University of Iowa.

"The Variation in the blackening of a Photographic Plate with Time of Exposure, Total Energy Remaining Constant," by P. S. Helmick, State University of Iowa.

"Note on the Ionizing Potential of Metallic Vapors," by H. J. van der Bijl, New York City.

A. D. COLE,
Secretary

THE BIOLOGICAL SOCIETY OF WASHINGTON

THE 558th meeting of the society was held in the Assembly Hall of the Cosmos Club, Saturday, October 21, 1916, called to order at 8.10 by President Hay, with 50 persons in attendance.

The president announced the death of Professor F. E. L. Beal, a member of the society, distinguished for his work in economic ornithology.

On recommendation of the council Mrs. Ella M. Enlows was elected to active membership.

Under the heading brief notes, exhibition of specimens, the following informal communications were presented:

Mr. A. L. Quaintance called attention to a new peach pest (related to the coddling moth), lately found in the District of Columbia and immediate vicinity. These remarks were illustrated by lantern-slide views of the insect and its work.

Dr. C. W. Stiles commented on zoological nomenclature and gave notice that it was the intention to set aside the rules of strict priority with reference to *Holothuria* and *Physalia* and to use these terms for the animals to which they are currently applied in the usual text-books.

Dr. Stiles also commented on recent cases in which trichina had figured in certain lawsuits. He expressed the view that with the purchase of meat products went the requirement that the product should be properly cared for and that in the case of pork this care required cooking before consumption. It was somewhat unfair to hold the seller of trichinous meat entirely responsible.

Dr. L. O. Howard cited an instance in which a cockroach was figuring in a lawsuit. A man was suing a Texas railroad for damages on the ground that typhoid fever had been contracted through his drinking pop which had been contaminated by a cockroach, which had apparently been in the bottle before the man drank the pop purchased of the common carrier.

The regular program consisted of an illustrated lecture by Dr. Paul Bartsch: "Mollusk Collecting in the Philippines." Dr. Bartsch reviewed the work of previous collectors, gave an account of his own collecting expedition, describing the methods and apparatus used; he spoke of mollusks as a source of food for the natives, their method of gathering

them; he called attention to the variations of these animals as found on different islands; showed the necessity of exact locality determinations on specimens; and discussed the geographic distribution of the Philippine molluscan fauna, pointing out its possible origin from other islands or land masses. The lecture covered not only the land mollusks, but the marine forms as well.

The 559th meeting of the society was held in the Assembly Hall of the Cosmos Club, Saturday, November 4, 1916, called to order at 8 P.M. by President Hay, with sixty persons present.

On recommendation of the council the following persons were elected to active membership: Dr. Wm. B. Bell, Biological Survey; Francis Harper, Biological Survey; H. E. Anthony, American Museum of Natural History, and A. B. Howell, Covina, California.

The president announced the death of Dr. E. A. Mearns, a member of the council of the society and distinguished for his work in birds, mammals and other branches of natural history.

Under the heading of brief notes and exhibition of specimens, Dr. R. W. Shufeldt exhibited a specimen of the Japanese giant salamander and made some remarks on its habits and habitat.

The regular program consisted of four papers as follows:

A Review of Recent Work on the House-fly: R. H. Hutchison.

This paper was restricted to a discussion of recent studies on the preoviposition period, the range of flight and the question of the over-wintering of the house-fly. The remarks on the preoviposition period summarized a recent bulletin of the Department of Agriculture on this subject (Bulletin 345).

In discussing the range of flight, attention was directed to the fact that up to 1914 the longest recorded flight was 1,700 yards. During the season of 1915 experiments were carried out in a suburban locality near Washington by Max Kisliuk, Jr., under the direction of the writer. In these, several records of from 1,800 to 2,175 yards were obtained. These were compared with the records obtained by R. R. Parker during the same season at Miles City, Montana. His longest record was 3,500 yards.

The question of how the house-fly overwinters in this latitude was said to be still undecided. It was pointed out that flies were not killed by the first heavy frost, as has often been stated; in fact a large percentage revived after several nights' exposure to minimum temperatures of 25° F. They are killed by temperatures of 15° F. Flies were found emerging up to the first week in December, and these late forms were found in heated buildings until the end of January. None were again seen till April 27. Other observations were cited as indicating that flies do not overwinter in the adult state, but, on the other hand, a long series of experiments and observations failed to give any positive evidence that they overwinter in the larval or pupal state.

Recent Spread of the Cotton Boll Weevil: W. Dwight Pierce.

A brief history of the movement of this pest through the United States suggests from a study of specimens collected in all parts of the infested regions of North America that there are three lines of dispersion. It seems probable that the boll weevil originated in Guatemala or some other portion of Central America and that the most typical strain migrated northward through the mountains of Mexico into Arizona, where it is now found as a native species on the wild cotton-like plant *Thurberia thespesioides*. The main migration was along the Gulf Coast through the cultivated cotton regions into the United States. The third line of dispersion was through Yucatan across the Gulf, to Cuba. Specimens collected at the three termini of these dispersions appear to be very distinct varieties. That variety which is found on cultivated cotton in the United States is the smallest found and the most variable. The movement of the weevil is controlled by the amount of food supply, which regulates the time and distance of natural movement by winds and floods; and by artificial agencies.

The most interesting development of the present year is the extension of the weevil to the northern limits of cotton growth in Oklahoma and Arkansas into Central Tennessee; eastward to the Atlantic Ocean south of Savannah; and the infestation of practically all the cotton region of Florida. The only Sea Island cotton section now not infested is that of South Carolina.

Remarks on Entomological Inspection and Disinfection of Products offered for Entry into the United States: E. R. Sasscer.

A brief review of the Plant Quarantine Act of 1912 was given, pointing out the principal features of the act relating to the control of stock entering the states and what is required of the broker, the nurseryman, or party importing plants or plant products. The quarantine relating to insects were referred to, and lantern slides of a number of these quarantined insects and others collected by inspectors were shown. Brief mention was made

of the method of examining nursery stock in the District of Columbia, and it was shown that such stock was naturally divided into commercial material, including plants and plant products received by florists, department stores and private individuals; and departmental material, including plants and plant products introduced by the various offices of the Department of Agriculture, more particularly the Office of Foreign Seed and Plant Introduction. Some time was devoted to discussing the new method of disinfecting cotton, and lantern slides were shown exhibiting the plants which are now operating in Boston, Mass., Brooklyn, N. Y., Newark, N. J. and Oakland, Calif.

An Outline of the Glow-worms of the American Family Phengodidæ: H. S. Barber.

M. W. Lyon, Jr.,
Recording Secretary

THE AMERICAN ASSOCIATION OF VARIABLE STAR OBSERVERS

On November 18, 1916, the American Association of Variable Star Observers held its fourth annual meeting at the Harvard College Observatory, Cambridge, Mass., at the invitation of the director, Dr. E. C. Pickering. The meeting was called to order in the library of the institution at three o'clock with twenty-two members present. The results of the previous year's work were carefully discussed and more definite plans adopted for the future course of the association. Numerous light curves and plottings pertaining to the work were on exhibition, illustrating the observations on variable stars, particularly those of long period.

Later, a tour of the observatory was made, at which time Professor Pickering and Miss Cannon explained in detail the work of the astro-photographic department, and Professor King explained the manipulation of the different photographic telescopes. This was followed by a lantern-slide exhibition of views of Arequipa, Peru, and the work of the Southern Station of the Harvard College Observatory by Mr. Campbell.

The meeting then adjourned to the commodious quarters of the 12-inch polar telescope, when nineteen experienced observers had the unique opportunity of observing the same variable star, *SS* Cygni, under like conditions, with an average deviation between observers of only 0.14 magnitude.

From seven until ten o'clock Professor Pickering acted as host at a dinner given to the members of the association. Following the dinner many of the members enjoyed the opportunity of observing with the historic 15-inch equatorial until the wee sma' hours of the morning.

The next day a small party availed themselves of the chance to visit the well-equipped students observatory at Wellesley College, by the courtesy of the director, Dr. J. C. Duncan.

In no period in the history of astronomy has an opportunity offered itself, as at the present time, whereby a group of amateur astronomers has been able to combine and organize themselves for such useful scientific work. In fact no other branch of science offers this possibility so completely, in which a two-fold purpose is so well accomplished, namely: service and contribution to science and personal pleasure to those taking part therein.

Not all the problems of astronomy are so easily adaptable or inviting to amateurs, as this study of variable stars. Nevertheless, in the past five years a most productive field of research has been developed, and one which has called together one of the most enthusiastic assemblages of men and women, some forty in number and from all the different walks of life.

The study of variable stars is one of the oldest branches of astrophysical astronomy, and it was not until twenty-five years ago that systematic work was undertaken. To this work the Harvard College Observatory has devoted, under the directorship of Dr. E. C. Pickering, the greater part of its time and resources. The methods and results in this study have proved so simple and attractive that it has lent itself admirably to non-technically trained astronomers, with the result that in 1911 there was formed this association of amateur observers, with Mr. Wm. Tyler Olcott as its secretary and prime mover. From the character of the work thus far performed, a number of its members have recently received recognition by election to membership in the American Astronomical Society.

F. E. B.

SCIENCE

FRIDAY, DECEMBER 29, 1916

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MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

RECENT PROGRESS IN SPECTROSCOPY[1]

WE should pause a moment to pay a tribute of respect to the eminent physicists who have died during the past year. Among these may be named John Oren Reed, of the University of Michigan; Arthur W. Wright, one of the pioneers in physical research in this country; Cleveland Abbe, the father of the Weather Bureau; Sylvanus Thompson, the many-sided scholar; Ernst Mach, the philosophic thinker, and Pierre Duhem, the mathematical physicist. We honor these men for their achievements, but we need not grieve that they have left us, for their full day's work was done; but sorrow we must over the needless and untimely end of many young men who had given promise of brilliant careers, and countless others, whose names we shall never know, whose potential genius has been sacrificed to the Moloch which is the mongrel offspring of the union of a brutish feudalism with the vampire of commercial exploitation. While we may form some conception of the loss of life and property in the great war, no one can ever guess the extent of the irreparable loss to humanity caused by the destruction of embryo scholars and statesmen, artists and scientists. It is the irony of fate that so many scientists have been the victims of the conditions arising from ignorance, superstition, greed and devotion to outworn traditions

[1] Address of the vice-president and chairman of Section B—Physics—of the American Association for the Advancement of Science, New York meeting, December, 1916.

which science has ever sought to remedy; and yet there are many who hold science in some measure responsible for the terrible destructiveness of this war. Fire is man's friend, but it may become a terrible scourge when uncontrolled; and so the beneficent discoveries of science may be perverted to evil ends. We must remember, however, that death-dealing devices based on scientific discoveries may be the defense of the rights and liberties of peoples as well as the instruments of those who would devastate the world for their own advantage. There have always been those who have exploited the discoveries of science for their own selfish ends, but who can point to one of these exploiters who was himself a scientist? When we are told that the ends of science are material, let us think of Faraday, who never had time for money-making; when we are told that the aims of science are selfish, let us think of the men engaged in medical research who have sacrificed themselves to discover how others might be saved. Such men are typical of the ideals of science. Yet it is true that we are sometimes too much absorbed in our individual work, although our aims may be unselfish. With the lesson before us of the great cataclysm in Europe, we must not only recognize our greater responsibility in carrying forward scientific investigation, but we must likewise seek to arouse in our people a fuller realization of the relations of this work to their own happiness and prosperity. Conditions and habits of thought similar to those which have brought disaster upon Europe are not entirely absent from our own country, and will have similar results if not remedied in time. Certain social, economic and political ills which are held to be inevitable to imperfect humanity by minds which move in the grooves of tradition or of legalistic logic may be found capable of improvement if treated by scientific methods, which seek the truth regardless of the harm it may do to ancient superstitions, prejudices and privileges. We must look to those who think scientifically, even though they may not call themselves scientists, to replace our haphazard ways in agriculture, business, manufacture, law and politics, our criminal wastefulness and careless extravagance, by more efficient methods, not only to the end of increasing national prosperity, but still more to the end of promoting intellectual development, universal justice and happiness, unselfish and enlightened patriotism, and exalted ideals of life and conduct. Fortunately there seems to be a growing tendency to recognize the service which science may render to society. For the first time in our history, our government has sought advice from scientific men, and those who have been called upon are giving their services fully and loyally, with no thought of pay or political preferment.

It seems not altogether irrelevant to preface my remarks with this protest against some current criticism of science; but now I turn to the specific subject of my address.

Ten years ago the subject of Professor Crew's vice-presidential address was "Facts and Theories in Spectroscopy." Since that time some notable discoveries have been made and some remarkable theories have challenged attention. It is my purpose to review a few of the more important experimental results and to discuss the relations of some of them to theories brought before you in two recent vice-presidential addresses on "Atomic Theories of Radiation" and "The Theory of the Nucleus Atom." Inasmuch as it will be necessary to refer to them, I will restate the salient features of the theories which have attracted the most attention.

Planck derived an expression for the

spectral energy distribution of black-body radiation from the assumption that the radiation was emitted and absorbed by electric oscillators in definite quanta, each equal to the frequency of the oscillator multiplied by a universal constant, h, the wirkungsquantum. Later he modified this theory so far as absorption is concerned. Einstein and others went further in assuming that these quanta preserve their identity in their propagation through space, thus reviving a form of corpuscular theory. This extreme view has been generally abandoned, but it has been found impossible to explain away the wirkungsquantum h. It appears in too many relations to be the result of chance. The work of Millikan in particular proves the exact validity of Einstein's relation $Ve = h(\nu - \nu_0)$ in the photoelectric effect, in which Ve is the measure of the emission energy of the electrons, ν the frequency of the incident light, and ν_0 the minimum frequency which will cause emission of electrons. A similar relation appears to hold good in many cases of X-ray and light spectra. It seems probable that this constant depends upon atomic structure only, and affects radiation through space only in so far as emission and absorption are determined by atomic structure.

The theory of the nucleus atom is likewise of fundamental importance in spectroscopy. The work of Rutherford and others leaves no escape from the conclusion that the nucleus of the atom is a concentrated group of positive charges and electrons, with an excess of positive elementary charges approximately equal to half the atomic weight, while the same number of electrons circulate about the nucleus in rings. The spectroscopist must try to fit his theories to these probable facts, but he is met at the outset with apparently insuperable difficulties in accounting for the stability of such atoms and for the manifold complexity of spectra according to accepted electrodynamical laws. Bohr cut the Gordian knot by supposing that the classic laws apply only to conditions of stability, when no energy is radiated, and that radiation attends the transition of an electron from one state of stability to another, the frequency being determined by the relation that h multiplied by the frequency is equal to the difference between the energies of the system in the two stable states. In the case of hydrogen, to which he assigns one radiating electron and one nucleus charge, it is difficult to account for the existence of so many stable states, for the failure to radiate while subject to uniform radial acceleration, and for monochromatic radiation while passing between two positions of stability. Nevertheless Bohr derived an expression like that of Rydberg which locates accurately not only the Balmer series, but also an infra-red and an ultra-violet series predicted by Ritz and found by Paschen and by Lyman, respectively. His attempt to apply the same method to helium led to results which are still in dispute, and which will be referred to later.

In reviewing recent progress we may begin with that field in which this country has taken a leading part—that of astrophysics. This domain belongs as much to the physicist as to the astronomer. The heavenly bodies are laboratories on a vast scale, in which nature has provided conditions of temperature, pressure and electrical state which we may never hope to rival on the earth. The spectroscope gives us data from which it may be possible to form some idea of these conditions by comparison with our feeble laboratory imitations of celestial phenomena, and conversely, the latter may aid in the interpretation of terrestrial phenomena.

One of the most fruitful astronomical applications of the spectroscope is to the

determination of velocities in the line of sight, by the Doppler-Fizeau principle. A large mass of such data has been collected, from which some important generalizations have been derived. For example, Campbell has determined the velocity and direction of motion of the solar system through space, and has found a remarkable and as yet unexplained relation between the velocities of stars and their apparent age, the redder and presumably older stars and a class of nebulæ having in general the greater velocities. It likewise appears that two immense star streams are crossing each other in the Milky Way. Many spectroscopic binaries have been discovered and their orbits determined, and recently there have been found remarkable displacements and rotations in nebulæ which may throw some light on the nature and destiny of these bodies. The spectroscope has enabled astronomers to undertake the ambitious task of tracing the course of stellar evolution.

The most ingenious and fruitful device for studying the sun is the spectroheliograph, invented by Hale in 1892. With this instrument photographs of the distribution of a given constituent of the solar atmosphere may be obtained by restricting the light falling on the photographic plate to the wave-length of one of the characteristic lines of the element. The configuration of the hydrogen clouds in the neighborhood of sunspots led Hale to suspect vortical motions in such regions. In 1908 the study of a number of plates, which showed that hydrogen flocculi were actually drawn into these spots from great distances, proved without question that sunspots are cyclonic areas of enormous extent. Thus the long-disputed question as to the nature of sunspots was answered, but this was not all. Vapors which emit or absorb line spectra are ionized, and as the more mobile electrons would diffuse more rapidly to higher levels than the positive ions, Hale inferred that the immense whirls of electrified vapors in the neighborhood of the spots must cause a radial magnetic field. If such fields are sufficiently intense, the longitudinal Zeeman effect should be produced. As a matter of fact, the spectrum of light from the spots is characteristically different from that of the surrounding photosphere, one of these peculiarities being the doubling of many lines. As Hale anticipated, an examination of the state of polarization of such lines showed them to be circularly polarized, and the direction indicated that the whirling vapor was negatively electrified. Hale likewise sought for the more minute effects which might be expected from the rotation of the solar atmosphere as a whole. A study of the breadth of spectral lines at different latitudes and the detection of traces of circular polarization at their edges showed that the sun possesses a magnetic field with polarity corresponding to that of the earth, but of much greater intensity. Although the atmospheric conditions on the earth are very different from those on the sun, it is possible that these investigations may assist us in solving the baffling problem of the earth's magnetism.

One of the most impressive facts revealed by the spectroscope is the substantial identity of constitution of the heavenly bodies. Everywhere we find evidence of the existence of such elements as hydrogen, sodium, calcium and iron. But we also find an infinitude of differences in the appearance of the lines, which we must attribute to differences of temperature, vapor density, pressure and electrical condition. It is suggestive to find that the spectrum of some stars resembles that of the arc, of others that of the spark. We may hope by comparing the spectra of these bodies with those produced in our

laboratories under varied conditions to reach some conclusions regarding their physical state. The Mount Wilson physical laboratory is doing much valuable work of this kind.

In the spectra of the solar corona and of nebulæ and nebulous stars certain lines are found which do not belong to known elements. This need not indicate any fundamental differences between the life history of such bodies and that of the older stars. Twenty-five years ago Lockyer's views regarding the dissociation of elements in the stars were treated with levity by most physicists and astronomers. To-day such notions are held to be quite rational. The more elementary forms of matter would naturally be of small atomic weight, and hence would diffuse to higher levels than the heavier elements, and might ultimately escape into space. If it were not for the fact that it is held captive in chemical combinations, we should know nothing of hydrogen. Helium first revealed itself to us through its solar lines, and would still be otherwise unknown to us were it not for its continuous production in radioactive processes. The elements giving the spectra of the corona and of the nebulæ are presumably of small atomic weight, and are possibly the units out of which more complex known elements are built, in later stages of development; or they may be, conversely, the results of the disintegration of such elements. It is not impossible that in the future we may detect traces of these elements on the earth or manufacture them by some powerful disintegrative process. Meanwhile deductions from known relations between frequencies of the spectral lines, their breadth, and the atomic weight of the elements may give us some clue to their atomic weights. Nicholson has succeeded in constructing hypothetical atoms with given nuclear charges and electron ring systems which give with remarkable accuracy the positions of the lines of the corona and nebulæ. Rayleigh showed from kinetic theory and Michelson proved experimentally that at low pressures the width of lines may be entirely due to Doppler displacements, which vary directly as the square root of the absolute temperature and inversely as the square root of the atomic weight. Buisson and Fabry have verified this law and applied it to the study of nebulæ. The width of certain lines, determined from the limit of interference, indicates that the temperature of the Orion nebula is about 15,000 degrees, and that two groups of lines are due to atoms of weights 2.72 and between 1 and 2 respectively. This is a remarkable confirmation of Nicholson's previous conclusion that the emission centers are of atomic weights 2.95 and 1.31.

During the past ten years the boundaries of the known spectrum have been greatly extended in both directions. The difficulties of investigation in the infrared are very great, but by the methods of reststrahlen and of focal isolation Rubens, working in succession with Nichols, Wood and von Baeyer, has isolated and measured certain regions of great wave-length. The longest wave-length measured is about .3 mm., while the shortest Hertzian waves so far obtained are 2 mm. long. The study of line radiation in this region is even more difficult, but Paschen and his pupil, the American Randall, have succeeded in measuring many lines extending to about 90,000 Ångström units.

In the ultra-violet Lyman has extended the region first made known to us by Schumann to a wave-length of about 600 Ångström units. Beyond this point it is difficult to go, on account of absorption, lack of sensitiveness of the photographic plate, and small reflecting power of speculum metal. Gratings ruled on silicon and photoelectric detectors may enable us to bridge the gap between these waves and

the much shorter ones which may be examined with the aid of nature's diffraction gratings, crystals, which have made the study of X-ray spectra possible.

Of all the discoveries of recent years, that of the wave nature of the X-rays and of a practical method of examining their spectra is the most remarkable and the most important, for it has revealed to us the most fundamental radiations of the elements and has given us a glimpse into the very heart of the atom. In quick succession Laue and his pupils demonstrated the diffraction effects produced by crystals, the Braggs showed how reflection might be employed to isolate waves of different lengths by a principle similar to that producing colors of thin plates, but of far greater resolving power by reason of the greater number of effective reflecting surfaces, and Moseley photographed many characteristic spectra by an extraordinarily simple method. He found that the principal lines in the spectra of a large number of elements were connected by a remarkably simple relation, namely that the square roots of the frequencies are proportional to the ordinal numbers, which increase by one in passing from one number of a periodic group to the next. When there are anomalies between the atomic weight and the place of an element in a group, this anomaly disappears when the atomic number rather than the atomic weight is considered. This work has been extended by others, notably by Siegbahn and Friman, to include nearly all the known elements between sodium and uranium, inclusive, with the result that all the atomic numbers between hydrogen and uranium are accounted for, with the exception of six gaps. As interpreted by Bohr's theory, the ordinal number which determines the frequency is the excess number of positive elementary charges in the nucleus, and these results are, therefore, in complete harmony with the theory of the nuclear atom developed by Rutherford, van den Broek, Soddy and others. The comparison of the X-ray spectrum of lead obtained by Siegbahn with the gamma-ray spectrum of radium B obtained by Rutherford and Andrade shows the identity of ten of the principal lines. This strikingly confirms the accepted theory of isotopes, or elements of different atomic weights, which are chemically and spectroscopically alike because they have the same resultant nuclear charge.

The positions of the principal lines are consistent with Bohr's general formula, but perhaps this relationship is purely formal. But whether or not this theory applies, apparently we can not dispense with the wirkungsquantum. In addition to the characteristic X-radiation of an element, there is a continuous spectrum, with a sharply defined boundary on the side of shorter wave-lengths. The investigations of Duane, Hull and D. L. Webster have shown that this boundary is accurately defined by Einstein's relation $Ve = h\nu$ for fields up to 110,000 volts. Such a simple law does not hold for the characteristic radiations; but Webster has shown that they do not appear until the voltage somewhat exceeds that demanded by the Einstein relation. The longest X-waves so far discovered by Siegbahn are about 12 Ångström units in length, so that there is not a very great gap between them and the shortest waves discovered by Lyman. The investigation of this region is difficult, but undoubtedly means will be found to attain success. Much also remains to be done in the study of details of X-ray spectra, which contain many weak lines, and possibly bands, which have not so far been carefully examined.

During the past ten years great advance has been made in our knowledge of spectral series. Rydberg, Ritz, Paschen, Fow-

ler and others have shown that a generalized form of the Balmer equation, with Rydberg's universal constant and a few special constants, is capable of wide application. Different combinations of a few constants have been found to give a number of related series, and many new lines so predicted have been found. The common limit and other numerical relationships between different series of the same element indicates that the different emission centers have some dynamic coupling and Rydberg's universal constant indicates a structural element common to all substances. According to Bohr, this quantity is a function of the electronic and atomic mass, the elementary electrical charge, and the wirkungsquantum h, and should slightly increase with increasing atomic weight. As it is commonly assumed that it is an absolute constant, careful measurements may furnish a test of the validity of Bohr's theory.

The relationships of frequency to atomic number found by Moseley recalls that Ramage, Watts, Runge and Precht and Hicks have found linear relationships between the squares of the atomic weights and the frequencies or frequency differences of homologous lines in the spectra of elements of the same group. Ives and Stuhlmann have shown that in some cases the results are improved by substituting atomic numbers for atomic weights, but the relationship is evidently not so simple as in the case of X-ray spectra.

The discovery of the Zeeman effect and the explanation of its simpler forms by Lorentz was the first step toward a rational spectroscopic theory. The later discovered complexities and anomalies, while they may defy mathematical analysis, do not lessen our confidence in the theory, for they are what we might expect as a result of complicated atomic structure. The same intellectual satisfaction does not attend the discovery of the analogous effect of an electric field, because the simplest cases are so complex that they can not be adequately explained by any theory yet proposed. The possibility of such an effect had long been the subject of speculation, but Stark was the first to realize and attain the necessary conditions for its occurrence. Lo Surdo also discovered it in the neighborhood of the cathode in capillary tubes. As in the case of the Zeeman effect, the phenomena are different when viewed transversely and parallel to the field. In each case the lines are split into a number of components, the number being different for different lines, even for those belonging to the same series. In the transverse effect the components are plane-polarized in hydrogen and helium, the stronger central lines vibrating at right angles to the field, and the stronger outer components vibrating parallel to the field. A remarkable relation is found for the series lines of hydrogen, helium and lithium. For each the number of principal normal components appears to be equal to the ordinal number of the line in the series. Higher dispersion shows that in the case of hydrogen each component is double. If this rule holds good throughout the series, the last known line, the twenty-eighth, would have 56 such components, an equal number polarized at right angles to these, and a number of weaker components of both kinds—truly a formidably complicated system. In general the longitudinal components appear to be unpolarized, although Miss Howell has found some anomalies with lithium and calcium. In some cases the components are unsymmetrical both in position and in intensity. Of all the other elements investigated, mercury alone shows a slight broadening. It might be expected that the great nuclear charges of heavy atoms would diminish the effect of an external

field. The inverse absorption effect has so far not been observed.

Long before the Stark effect was observed Voigt showed that such results might be expected from quasi-elastic forces in the atom and the stresses produced by the field. Schwarzschild has attempted to explain it by the ordinary laws of electrodynamics, and Warburg, Gehrcke, Garbasso and Bohr by Bohr's theory. Each attempt was successful in some respects, but each failed to account fully for all the components, their displacements and their state of polarization, and all the theories assign the same number of components to each line of a series, whereas one of the most significant features is the progressive difference in number of components, displacements and relative intensities in passing from one line to another. Stark not only rejects them all, but is led by his study of the phenomenon to finally abandon the quantum and light-cell theories, because he considers that he has proved that the greatest possible energy which an electron can acquire in its orbit falls far short of one energy quantum. Moreover, he argues that it seems impossible to explain the phenomenon in terms of Bohr's one electron. He concludes that a number of electrons must take part in the emission of a single line, each having the same frequency under ordinary conditions or in a magnetic field, but different frequencies when displaced unsymmetrically in an electric field. It is difficult, however, to understand why hydrogen has only one detachable electron if Stark's view is correct.

It has already been mentioned that at low pressures the width of lines may be ascribed entirely to the Doppler effect. The great broadening at higher pressures has never been explained, but it has been assumed that damping, collisions and rotations all play a part. Stark suggests that it may be largely due to atomic electric fields, which may exercise a large influence when the atoms are crowded together. It seems significant that the broadening increases with the ordinal number of a line in a series, is often unsymmetrical, and diminishes with increasing atomic weight in most cases, quite in harmony with the effects of an electric field. Nicholson and Merton have found that the broadening of hydrogen lines is in quantitative agreement with Stark's suggestion.

With changes in vapor density, pressure, temperature or the mode of excitation lines belonging to one series may weaken or disappear, other lines may be strengthened, and new lines may appear. We must assume that different groups of lines are due to different emission centers. These differences must depend upon the size of the particles, or upon the number and arrangement of electrons. Any theory must take account of the molecular or atomic state or the electrical charge of the emission centers. In some cases we have rather definite information on these points.

A number of elements emit band spectra under some conditions, line spectra under others. One conclusion which seems to be well established is that band spectra are emitted by molecules, line spectra by atoms. Universally we find that compounds give band spectra, never line spectra. If a compound is dissociated by the discharge the line spectrum of one or both constituents appears. Elements give band spectra with feeble excitation, line spectra when the discharge is so intense as to cause dissociation. It seems reasonable to infer that the band spectra of elements is likewise associated with the molecular condition. In the case of monatomic elements which give both band and line spectra electrical conditions must determine the nature of the radiation.

Radiation is an electromagnetic process,

and must be determined by the electrical state of the radiator. A molecule may be neutral or for a moment charged by the loss or gain of an electron. This type of ionization must actually occur, as indicated by the conduction of electricity through the vapor of a compound which shows no evidence of chemical dissociation. What causes the light emission? It may accompany the loss or gain of an electron by a neutral molecule, in which case the emission center would be charged. It may be due to the shock of elastic collision with an electron or ion, or to the reunion of an electron with a positively charged molecule, in which cases the emission center would be neutral. Luminous vapors emitting band spectra usually appear to be neutral at the instant of emission, so that it seems probable that band emission is due either to elastic shock or to the recovery of a lost electron. It is to be remarked that as a rule band spectra are not subject to the Zeeman, Stark or Humphreys-Mohler effect; in the exceptional cases it is probable that those subject to one of these effects are subject to all. It would be of interest to examine these cases with reference to the nature of the molecular charge.

Luminous vapors emitting line spectra appear, in many cases at least, to be positively charged. A sodium flame is attracted to the negative plate of a condenser. A metallic salt introduced near the cathode of a spark discharge colors the spark only in that neighborhood; if introduced near the anode, the color flashes entirely across the spark. The most promising method of verifying such conclusions appears to be by the study of canal or positive rays. Sir Joseph Thomson, from a study of the deflections produced by magnetic and electric fields, found that, with very few exceptions, no molecules of either elements or compounds carry a negative charge, while those with positive charges are common. No molecule acquires more than one positive charge. The atoms of but few elements are found with a negative charge, but all may acquire positive charges and many may be multiply charged. For example, krypton may have as many as five and mercury eight positive charges. Hydrogen never has more than one charge, which accords with Bohr's view that it has but one detachable electron.

Stark has reached similar conclusions from a study of the spectra of canal rays. In many cases the motion in the line of sight gives a Doppler effect. There is an undisplaced line due to the stationary gas and a displaced line due to the canal rays. A distinct separation between the displaced and stationary lines shows that the canal rays can not radiate until their kinetic energy reaches a threshold value, which Stark first interpreted in favor of the quantum theory, but which he now believes to represent the energy necessary for ionization. There may be two or even three displaced lines, with separations consistent with the view that the luminous centers are doubly or triply charged. The radiation is evidently due to collisions, for a reduction of pressure in the canal ray chamber causes a reduction of luminosity. In general, all series lines are subject to the Doppler effect. Fulcher has shown that nitrogen canal rays give the negative pole band spectrum, with displacements, but no other bands have been found to give this effect. The series lines of hydrogen show displacements, but they are not observed in the many-line spectrum except to a slight extent in a few cases. Stark concludes that the series lines are emitted by positive atom ions, and the lines of the secondary spectrum by neutral atoms. He thus associates the compound spectrum with band spectra, which he supposes to be due to neutral systems. It may

be remarked that Fabry and Buisson have concluded from measurements of the width of lines that both spectra are due to emission centers of atomic size. From a study of the displaced components of many elements, electronegative as well as electropositive, Stark concluded that in all cases line spectra are emitted by positively charged atoms. Aluminum atom ions may have one, two or three charges, which appear in succession as the voltage is increased. The same is true of argon. The red spectrum is apparently due to singly charged ions, the blue or spark spectrum to multiple charges. Mercury may have as many as four charges, each giving rise to a characteristic group of lines, all those due to multiple charges being spark lines. From an examination of many such cases Stark concludes that in general arc lines or those of the positive column are due to singly charged ions, sharp spark lines to double charges, and diffuse spark lines to triple charges. There are some apparent exceptions to this classification, but in the main the evidence seems to support his views, which are also consistent with the results obtained by Reichenheim from the study of anode rays. For the first time we are thus enabled to assign a common cause for spark lines produced under apparently very different conditions. They are found in the spectra of disruptive discharges, of the negative glow in vacuum tubes; in the intermittent or oscillating arc when rapid changes in potential occur, although the maximum potential may be small; near the poles of the arc, where the anode and cathode potential gradients are steep; in the electric furnace when the temperature is high; in high temperature stars, and, as found by Hemsalech and de Watteville, even in the green cone of the Bunsen flame, where chemical action is energetic. In all these cases we might expect multiple ionization to be favored.

Similar conclusions regarding the charges of emission centers may be derived from observations by Stark, Child, Strutt and others on the luminous vapors from an arc between charged condenser plates. The carriers of the line spectra are swept out of the field, while the luminous vapors giving band spectra are unaffected; or, if the lines of several series are present, their intensities are modified in different degrees by the electric field. Studies of the oscillatory spark by Schuster and Hemsalech, Schenck, Milner, Royds and others indicate that the spark lines do not persist as long as arc lines. If the emission centers of the former are multiply charged this is what we might expect.

Investigations on the mechanism of the spark give results which at first sight seem opposed to Stark's theory. All observers agree that the luminous vapors appear to be projected from the cathode, with different velocities for different lines, and the tacit assumption seems to have been made that they are negatively charged. That metallic vapors are projected from the cathode is evident from the fact of cathode disintegration, and probably the particles are initially negatively charged. We know very little concerning this phenomenon, but two things are almost certain—that only a small fraction of the metallic particles take part in the luminosity, and that these particles are not negatively charged while radiating. The large velocities indicated by the curvature of the streamers viewed in a rotating mirror do not give rise to a corresponding Doppler effect, and it seems highly probable that Hull and Royds are correct in their surmise that what happens is really the propagation of a condition of luminosity through vapor which continuously fills the gap after the first discharge. Electrons initially projected with a high velocity, which diminishes as the field intensity

drops to zero, and producing multiply charged ions in the beginning and singly charged ions toward the end of their course, would apparently account for all the observed effects.

While the experimental evidence seems to favor the idea that lines are emitted by positively charged centers, there is no *a priori* reason why neutral or even negative ions should not emit line spectra. It is quite possible that the canal ray lines which Stark attributes to singly charged ions may be emitted at the instant of neutralization; but we can not escape the conclusion that spark lines at least are emitted by positive ions unless we accept the improbable view that a multiple charge may be instantaneously entirely neutralized. Lenard inferred from the distribution of emission centers in the arc that the lines of the principal series are emitted by neutral atoms, those of subordinate series and spark lines by multiply charged atoms. Wien and others have suggested that line spectra may be emitted by molecules, but this seems improbable. On the other hand, we must admit the possibility of negatively charged centers which would probably exist only under exceptional conditions. Nicholson has, with success, assumed the existence of positive, neutral, and negative centers in accounting for the spectrum of the corona.

The fundamental importance of reaching definite conclusions as to the magnitude of the electric charge of emission centers is evident when we remember that any theory must take this into account. Bohr's theory rests upon the assumption that series lines are emitted by electrons previously detached as they return to equilibrium positions determined by the resultant charge of the system. In the case of hydrogen, if there be but one detachable electron, the radiating system must be neutral. If it can be shown without question that the emission centers of the Balmer series are positively charged, some modification of the theory seems necessary. Furthermore, if the centers are thus deprived of the one detachable electron, we must accept Stark's view that the series emission is due to electrons which can not be detached. Fulcher has pointed out the necessity for a similar conclusion with respect to helium. Some of its lines are attributed to doubly charged atoms; but these are identical with alpha particles, the nuclei of the atoms, from which the radiation must be emitted.

Beyond the probable fact that band spectra are usually emitted by neutral systems, there is little evidence upon which we may rest a theory. Emission may accompany the neutralization of a positively charged molecule by an electron or may be the result of internal vibrations due to collisions, without complete ionization. Stark believes that the band emission is due to the detachable valency electrons, although the coupling between them and more firmly bound electrons may cause the latter to take part.

Evidence supporting Stark's views is to be found in absorption spectra. Hydrogen shows no absorption until it is ionized by a current. The cold vapors of the alkali metals and of mercury show line absorption, but their susceptibility to the photoelectric effect indicates how ionization may be the prelude to absorption. All the corresponding emission lines appear to be due to singly charged emission centers. Absorption of the lines due to multiple charges does not take place until the vapor is highly ionized by electric discharges or high temperature. Substances which show band absorption under ordinary conditions, such as iodine, do not appear to be ionized when either emitting or absorbing. Both processes appear to be due to neutral systems. In such cases emission must be due to internal disturbances, without ioniza-

tion. The bands of some substances, such as nitrogen, are not found in absorption under any conditions, and the conditions of their occurrence indicate that the emission bands are due to the recombination of a detached electron with a positive molecule. The negative pole bands appear under the same conditions as spark lines, and it seems not improbable that they are due to the neutralization of a doubly charged molecule.

The spectral differences attending different stages of ionization are well illustrated by some recent experiments. Franck and Hertz found that mercury vapor is ionized by a field of 4.9 volts, and then emits the one ultra-violet line 2537. The Einstein relation $Ve = h\nu$ is fulfilled. McLennon and Henderson verified this conclusion, and also found that with a field of about 12 volts a second stage of ionization occurs, attended by the emission of the many-lined spectrum attributed by Stark to multiple charges. McLennon finds that zinc, cadmium and magnesium also give single line spectra which probably conform with Einstein's equation, which we should not expect to apply in a simple form to the many-line spectrum.

It appears from such experiments that there is a threshold value of kinetic energy which must be imparted to an emission center before it can radiate, which represents the work of ionization and is equal to a light quantum. Franck holds that this energy may be devoted either to ionization or to emission, but that both can not simultaneously occur. Stark believes that the two are coincident, the emission accompanying the rearrangement of electrons in the atom after one has been ejected. This suggests an explanation of quantum emission involving no departure from accepted electromagnetic theory.

The spectra of hydrogen and of helium are of particular interest because their atoms are of the simplest type and because it is possible that they are the basic units of which all elements are composed. The Pickering series in stellar spectra was attributed to hydrogen because of its numerical relationships with the Balmer series. The study of series relations led Rydberg to predict the occurrence of a principal series for hydrogen beginning at wave-length 4686, and this line was subsequently found in nebular and stellar spectra. After many attempts to reproduce these spectra in the laboratory, Fowler succeeded in 1812, by passing a powerful disruptive discharge through a mixture of hydrogen and helium. Produced only under such conditions, these must be classed as spark lines; and if Stark's views are correct and if they are really due to hydrogen, that element must have more than one detachable electron.

In applying his theory to the helium spectrum, and assuming one electron returning to a helium atom from which two electrons have been detached, Bohr obtained a formula which gives lines corresponding in position to those of the Pickering and Rydberg series, and also another series almost coincident with the Balmer hydrogen series. This remarkable conclusion was strengthened by Stark's discovery of 4686 in a helium tube which gave no lines of the ordinary hydrogen spectrum. He concluded from the canal-ray displacements that the emission centers were doubly charged. Evans also found the first members of all the series assigned to helium by Bohr, including that corresponding to the Balmer series, in a tube containing no hydrogen. The experimental evidence thus favors Bohr's theory, but we must remember the remarkable way in which the presence of one element may intensify or suppress the spectrum of another. For example, Lyman found that the ultraviolet series attributed without question to

hydrogen is greatly intensified by the presence of helium. It may be added that Merton has concluded, from a study of the width of 4686, that it is due to an atom smaller than that of helium.

Some light may be thrown on this problem by observations such as those made by Wright and others on the distribution of materials in nebulæ, as indicated by the length of the nebular lines. Wright finds that usually 4686 is confined to the nucleus; helium lines extend further, and those of nebulum and hydrogen still further. These results favor the view that the elements distribute themselves according to their atomic weights and that 4686 is due to an atom at least as heavy as that of helium. But this is not conclusive, because a high temperature line of hydrogen might be found only in the hot nucleus, if we grant the possibility of a higher degree of ionization for hydrogen.

Fundamental questions which are of importance to physicists and astronomers alike are involved in this problem, but it is evidently an elusive one. Curiously enough, as Fowler has proved by comparison with other spectra, general series relations would permit us to assign the disputed series to hydrogen or to helium impartially, and it seems possible that both elements may give the same spectrum under appropriate conditions. Bohr has also concluded, from the formula derived from the assumption of the return of an electron to a lithium atom which has lost three electrons, that lithium would emit lines close to the Balmer series. Bohr has not yet succeeded in applying his method to the case where an electron returns to a singly charged helium or lithium atom, and hence has not been able to account for the known helium lines, which are assigned by Stark to singly charged atoms. Nor has he taken account of atomic magnetic fields, which, as Humphreys, Allen and others have shown, may exercise an appreciable influence.

One of the most fascinating fields of research is that of fluorescence and resonance spectra, in which much work has recently been done, particularly by Wood. He has found that white light will excite the complete band and line resonance spectrum of sodium or iodine, but that a single exciting line will cause the emission of a line of the same length and also of a number of lines approximately equally spaced which may not always coincide in position with one of the absorption lines. Thus the vapor is caused to emit forced vibration, giving a spectrum not its own. As Wood has suggested, this method enables us to strike one key of the complex vibrating system of the atom, instead of the whole keyboard at once. Time does not permit a detailed account of this remarkable work, but it is evident that it may render great service in the study of the mechanism of the atom. Nor is there time to even mention any of the results obtained in the field of absorption spectra.

After reviewing the work of the past decade, we may feel encouraged by the progress that has been made both in the perfecting and application of spectroscopic methods of research and in the discovery of new phenomena. Some of these discoveries have led to fundamental revisions of our notions of atomic structure. The Rutherford atom has definitely displaced that of Thomson. In some respects this has seemed to make the problem more difficult, but it has at least defined it more precisely. Many attempts have been made to represent an atomic structure which would satisfy the necessary mathematical conditions, most of them so impossible as to be absurd or so speculative that they suggest no experimental tests of their validity. The great merit of Bohr's hypothesis is that it does lend itself to such tests, and

it is for that reason that I have paid special attention to the methods of experimental attack which seem to give the most concrete results in this connection. Hesitant as we may be to accept in all its details a theory which asks us to abandon laws upon which we have pinned our faith, this theory, and the quantum theory as well, may be the flashes of genius which reveal incompletely the outlines of the truth toward which we struggle along a dimly lighted path. Fuller knowledge may resolve some of our difficulties and reconcile apparent contradictions. Ptolemy's theory of epicycles would appear wholly irrational to one acquainted with Newton's laws but ignorant of Kepler's conclusions, yet it correctly described the facts as Ptolemy saw them. Some day the Kepler and the Newton of the atom may appear, but their task will not be an easy one. If the astronomer is baffled by the problem of three bodies which he can see, how can we expect to define the exact laws determining the motions of the invisible hosts of electrons and positive charges in an atomic system? How can we hope to correctly picture the mechanism which emits radiations of almost infinite complexity, or account for the additional complications called forth by external forces? We may be almost tempted to accept the pessimistic view expressed by Planck in his Columbia lectures, that nothing in the world entitles us to believe that it will ever be possible to represent completely through physical formulæ the inner structure of the atom. And Kayser has said:

> A true theory must assume a complete knowledge of electrical and optical processes, and therefore is an Utopia.

But even if we never reach the goal, who can set a limit to our approach to it? We may never set foot upon the promised land, but some day we may perceive its shadowy outlines dimly from afar.

University of California E. P. Lewis

WILLIAM RANE LAZENBY

William Rane Lazenby, professor of forestry in Ohio State University, died at Columbus on September 14 of pneumonia. In the passing of Professor Lazenby there is removed from us one who has devoted his life with marked success to the advancement of agriculture and agricultural education.

He was born on a farm at Belona, Yates County, N. Y., December 5, 1850; he entered Cornell University in the fall of 1870, and graduated with his class in 1874. During this period, he not only kept up his studies, but also supported himself by labor, first, on the university farm and campus, and later, in the botanical department. This at times was an extremely difficult thing to do, as the compensation for such labor was small and the time that he could spare for this work was limited. At times he was greatly discouraged; but the steadfastness of purpose, which was a prominent characteristic of his entire career, kept him at his self-imposed task. In spite of the handicap of the necessity of self-support he was so successful in his studies that he won the Ezra Cornell prize in agriculture, and on graduation he was made a member of the teaching staff of the university.

His first appointment was as instructor in horticulture; later he was promoted to an assistant professorship in horticulture, which position he held till he was called to the Ohio State University. As he was the first member of the Cornell faculty whose duties were limited to horticulture, he may be regarded as the founder of the horticultural department of this institution.

He was called to the Ohio State University as professor of botany and horticulture in 1881, which position he held till 1892, when his title was changed to professor of horticulture and forestry; since 1910 his field has been restricted to forestry.

Professor Lazenby had published much on the subjects that he taught. He spent many of his summer vacations in studying horticulture and forestry in Europe. He was a fellow of the American Association for the Advancement of Science, a founder and past president of the Ohio Academy of Science and a life

member of the American Pomological Association and the American Forestry Society. His wife and a daughter, who is a student in Smith College, survive him.

In his undergraduate days at Cornell, Lazenby was a great favorite with his fellow students. His genial good nature, his unselfishness, and his great earnestness won the hearts of those associated with him. Already at that early period in his career, he was devotedly interested in the cause of agriculture, and took a prominent part in the work of the Grange and of agricultural and horticultural societies, and later his influence in these organizations did much to bring their support to the development of the agricultural work at Cornell. He also took a prominent part in the movement that resulted in the establishment of the agricultural experiment station at Geneva, drafting the bill, the passage of which by the New York State Legislature established this station.

While Professor Lazenby found his great interest in life the mastery and development of his special field in science, it was the human side of him that had the strongest hold on his friends and colleagues. He never lost his interest in the struggles of students with limited means and in a quiet way extended aid to many of them. He never lost an opportunity of service to his friends or others in need; sympathy, helpfulness and loyalty were his characteristic qualities as a man and friend; and his loss to all of us who knew and loved him is irreparable.

J. H. COMSTOCK

SCIENTIFIC EVENTS

ANTHROPOLOGICAL ESSAYS IN HONOR OF PROFESSOR W. H. HOLMES

A FIVE-HUNDRED page volume of anthropological essays abounding with pertinent and beautiful illustrations was presented to Mr. William Henry Holmes, head curator of anthropology in the United States National Museum, on the occasion of his seventieth birthday, December 1, 1916. The volume is a tribute by his friends and colaborers in the study of anthropology, forty-four of whom contributed original articles for publication in the anniversary volume. The book, of which only 200 copies were printed, was edited by Mr. Frederick W. Hodge, ethnologist-in-charge of the Bureau of American Ethnology of the Smithsonian Institution.

The presentation took place at a dinner held at the Lafayette Hotel, at which were present most of those who took part in the preparation of the book, and proved a complete surprise to the guest of honor. Mr. Holmes has been engaged in scientific investigations under the government for forty-five years; first with the government geological surveys, then with the Geological Survey, and finally the Bureau of American Ethnology, and the United States National Museum. In fact, he has been in the scientific service of the government continuously since 1871, with the exception of three years (1894–97) during which time he was curator of anthropology in the Field Museum of Natural History and professor of anthropic geology at the University of Chicago. Besides being a geologist and anthropologist, Mr. Holmes is an artist of note, and has been curator of the National Gallery of Art, a branch of the National Museum, since its establishment several years ago. Incidentally, he has been the representative of the government at seven national and international expositions.

His influence upon the work of his collaborators and assistants has been very marked. The note of appreciation, which prefaces the anniversary volume of anthropological essays, remarks in part:

> This volume . . . must not be regarded as merely commemorative of the day on which you achieve the seventieth milestone in your journey of life. It is rather an epitome of the influence you have exerted on others through the passing years, a testimonial of your masterly leadership in both science and art. You are still at the height of your remarkable activity. At no time in your career have you done more noteworthy work in the advancement of knowledge than you are doing now. So with your splendid reserve of force, and with the inspiration derived from the important results of a generation of research in American archeology, we hope and expect you will continue to bestow upon us the influence of that experience for years to come.

Accept then, this book, not as measure of our indebtedness for what you have already accomplished, but as a token of our affection, our appreciation and high esteem.

Among the many interesting and instructive articles are thirteen written by members of the staff of the Smithsonian Institution and its branches. "The Cliff Ruins in Fewkes Canyon, Mesa Verde National Park, Colorado," is the subject of a report by Dr. Jesse Walter Fewkes of the Bureau of American Ethnology, on his recent excavation and repair of Oak-tree House, Painted House and other prehistoric ruins in the canyon. "Music in its Relation to the Religious Thought of the Teton Sioux," is the title of an article by Miss Frances Densmore. Other articles pertaining to the work of the Bureau of Ethnology are by Mr. F. W. Hodge, Miss Alice C. Fletcher, J. N. B. Hewitt, John Peabody Harrington, Francis LaFlesche, Truman Michelson and John R. Swanton.

Dr. I. M. Casanowicz, assistant curator of old-world archeology of the National Museum, writes on "Parallels in the Cosmogonies of the Old World and the New." Three other members of the museum staff contributed articles as follows: Dr. Walter Hough, "Experimental Work in American Anthropology and Ethnology," in which he speaks of the work, methods and influence of Mr. Holmes among American scientists; Dr. Aleš Hrdlička, "Anthropology of the Chippewa," wherein he reports on his studies of the White Earth Chippewa in an endeavor to establish their identity as full or mixed bloods; and Neil M. Judd, "The Use of Adobe in Prehistoric Dwellings of the Southwest."

Contributions from other eminent anthropologists include discussions on "The Cult of the Ax," by George Grant MacCurdy; "The Supplementary Series in Maya Inscriptions," by Sylvanus G. Morley; "The Domain of the Aztecs and Their Relation to the Prehistoric Cultures of Mexico," by Alfred M. Tozzer; "Cardan's Suspension in China," by Berthold Laufer, and articles by Gerald Fowke, Edgar L. Hewett, George G. Heye, Charles Peabody, Charles C. Willoughby, A. V. Kidder, S. A. Barrett, Franz Boas, Theodoor de Booy, David I. Bushnell, Jr., William Churchill, Roland B. Dixon, William Curtis Farabee, P. E. Goddard, George Byron Gordon, Albert Ernest Jenks, A. L. Kroeber, Robert H. Lowie, Charles W. Mead, William C. Mills, Warren K. Moorehead, Nels C. Nelson, George H. Pepper, Marshall H. Saville, Frank G. Speck, Herbert J. Spinden and Clark Wissler.

The volume closes with a bibliography of Mr. Holmes comprising 184 titles, which was compiled by the librarian of the Bureau of American Ethnology.

DEDICATION OF A TABLET IN HONOR OF PROFESSOR VOLNEY M. SPALDING

SEVERAL years ago at a meeting of the American Association for the Advancement of Science at Baltimore, a number of former students of Professor Volney M. Spalding got together and proposed that a fund be collected for the purchase of a memorial to their teacher. They selected a committee composed of Dr. Erwin F. Smith, of the Bureau of Plant Industry, Professor L. R. Jones, of Wisconsin University, and Professor F. C. Newcombe, of Michigan University, to select and secure the memorial.

The committee decided a bronze tablet the most suitable object for the purpose, and addressed a circular letter to Professor Spalding's former students, asking that the contribution from each be small so as to allow many to participate. Over one hundred sent in contributions, and the tablet was designed and cast. The authorities at Ann Arbor decided that the tablet should be erected in the proposed new botanical building. With the completion of the natural science building last year, the tablet was placed on the wall in the main corridor of the botanical section of the building, and dedicatory exercises held. President Hutchins presided, addresses were made by Professors J. E. Reighard and E. C. Goddard, Professor F. C. Newcombe presented the tablet in behalf of the former students of Professor Spalding, and Regent Beal accepted the tablet in behalf of the university. The inscription reads:

VOLNEY MORGAN SPALDING

In commemoration of the twenty-eight years of faithful service as teacher of botany in this university (1876 to 1904) and as a token of love and gratitude this tablet is erected by 100 of his former students.

Per naturae opera mentem ad humanitatem fingebat atque virtutem. Done in MCMIX.

It may not be known to some of Professor Spalding's pupils and friends that, since resigning from the staff of the Carnegie Desert Laboratory at Tucson seven years ago, Professor Spalding with his wife has resided the most of the time at the sanatorium at Loma Linda, Calif., where, though considerably crippled by rheumatism, he enjoys a measure of health and happiness, and is held in the highest regard by both patients and staff, with whose ills he sympathizes and to whose mental enjoyment he daily contributes.

SMITHSONIAN REGENTS MEETING

THE Board of Regents of the Smithsonian Institution assembled at the institution on December 14, 1916, for their 71st annual meeting, Chief Justice Edward D. White, chancellor, presiding. The others present were: Vice-President Thomas R. Marshall; Senators Henry Cabot Lodge, of Massachusetts, and Henry F. Hollis, of New Hampshire; Representatives Ernest W. Roberts, of Massachusetts, and James T. Lloyd, of Missouri; Dr. Alexander Graham Bell, and Mr. John B. Henderson, Jr., of Washington, D. C., and Mr. Charles F. Choate, Jr., of Boston.

Dr. Charles D. Walcott, secretary of the institution and the administrative representative of the board, announced the re-appointment by the Speaker of the House of Representatives, of Scott Ferris and Ernest W. Roberts, and the appointment of James T. Lloyd, of Missouri, to succeed Maurice Connolly, of Iowa, whose term in Congress had expired. Announcement was also made of the re-appointment of Dr. Alexander Graham Bell, of the City of Washington, as "citizen" regent, by a joint resolution of Congress. Dr. Bell was also re-elected a member of the executive committee.

The resignation of Dr. Andrew D. White, of Ithaca, New York, was presented and accepted. A resolution was adopted by the board in appreciation of his long and valued service, of nearly thirty years.

The report of the executive committee of the board was presented for the fiscal year ending June 30, 1916, and accepted. The report showed the total resources of the institution to be $1,048,134.38, and the total income for the past year to be $107,662.46. A summary of the appropriations for the several governmental branches of the institution for the fiscal year was also made.

The secretary's report for the fiscal year was presented and accepted by the board, following which he reviewed the recent work carried on and outlined the principal operations now under way. He stated that in September work was begun on the foundation of the million-dollar building donated by Charles Freer, for his collections of American and Oriental art presented to the institution some time ago, and that present indications point to its completion within two years.

A bequest by the late artist, Henry W. Ranger, gives the National Gallery of Art an opportunity of selecting and purchasing such paintings of deceased American artists as may be deemed desirable, the selected paintings being paid for from the Ranger fund.

Mention was made of the need of more funds for the proper classification and public installation of the National Museum's art-industrial collections, believed to be the richest and most varied of their kind in the country. Extensive and valuable additions to the several collections of the museum were reported as having been acquired during the year.

Among the researches of the Bureau of Ethnology, the secretary mentioned the excavation and repair of a large pueblo ruin in Mesa Verde National Park, conducted in cooperation with the Department of the Interior; and field investigations among the Fox, Quilente, Iroquois and Cherokee Indians.

In the report concerning the National Zoological Park, the need of certain tracts of land for entrances and boundaries was reported,

and the statement made, that an item for the sum required had been included in the park estimates for the fiscal year of 1918. The appointment of Ned Hollister, assistant curator of mammals of the National Museum, as superintendent was also announced. In coöperation with two other zoological institutions, the park sent a representative to South Africa to collect and purchase live animals. Recent advices from him seem to indicate excellent results.

The secretary reported briefly on the work of the astrophysical observatory on Mount Wilson, in connection with the investigations concerning the variations of the sun. An allotment has been made to Director Charles G. Abbott for the maintenance of an astrophysical observatory in South America for the purpose of determining the transmission of the sun's rays through the atmosphere.

Dr. Walcott, as chairman of the executive committee of the National Advisory Committee for Aeronautics, which organization has taken up much of the work that the Langley Aerodynamical Laboratory aimed to perform, reported considerable progress. An allotment from the Langley Laboratory, in connection with the Weather Bureau, provides for the investigation of problems of the atmosphere in relation to aeronautics, which investigation, it is expected, will ultimately result in the mapping of the atmosphere over the whole United States and adjoining areas, to a height of 20,000 feet.

Other reports concerning the operations of the Research Corporation, which handles, among other things, the Cottrell patents for the precipitation of dust, etc., the researches of Dr. Cottrell in fog precipitation and the work of Dr. C. Hart Merriam in zoology under the Harriman fund.

Among the expeditions and field work conducted recently, the secretary spoke of his own geological investigations in Alberta and British Columbia, the work of Dr. W. L. Abbott, whose gifts of ethnological and zoological specimens and generous financial contribution have been most valuable; and the zoological expedition being maintained in north China, through the generosity of another friend of the institution.

The secretary stated that the Collins-Garner Congo Expedition, in the interests of the Smithsonian Institution, was about to leave for the French Congo, where zoological collections would be secured for the National Museum, the institution and museum being represented by Mr. Charles R. W. Aschemeier.

Arrangements for a three years' lease of the Cinchona Botanical Station by the institution from the government of Jamaica, were reported as practically completed. The main building, known as "Bellevue House," situated on the Island of Jamaica, together with the offices, laboratories and other buildings and about ten acres of land, are leased by the institution for the furtherance of the study of botany in this region. Assignments to botanists desiring to prosecute studies there, will be made by a committee composed of representatives of the 14 organizations which contributed the funds for the lease.

Mention also was made of the work of the other two government bureaus under the Smithsonian; the International Catalogue of Scientific Literature, and the International Exchange Service.

Following adjournment, the regents inspected an interesting exhibit illustrating some of the many lines of work in which the institution or its branches took part during the past year.

SCIENTIFIC NOTES AND NEWS

The meeting of the American Association for the Advancement of Science and of the National Scientific Societies affiliated with it, opened in New York City on December 26 with a very large attendance. The address of the retiring president, Professor W. W. Campbell, of the Lick Observatory, on "The Nebulæ," given on the evening of the first day, will, owing to the extensive illustrations, be printed in *The Scientific Monthly*. We hope, however, to give an abstract in Science. There is printed elsewhere the address of Professor E. P. Lewis, chairman of the Section of Physics, and this will be followed by other addresses

given by chairmen of the sections and of the presidents of the affiliated societies. There will also be printed in SCIENCE the transactions of the association and reports of the proceedings of the different societies, as well as many of the more important papers presented before them.

THE number of papers announced in advance to be read before the New York meeting of the American Association for the Advancement of Science and affiliated societies listed under the related sections of the association is:

A—Mathematics and Astronomy	57
B—Physics	38
C—Chemistry	18
D—Engineering	50
E—Geology and Geography	51
F—Zoology	217
G—Botany	292
H—Anthropology and Psychology	137
I—Social and Economic Science	49
K—Physiology and Medicine	355
L—Education	53
M—Agriculture	15
Total	1,332

PROFESSOR M. I. PUPIN, of Columbia University, has been elected president of the New York Academy of Sciences, which in 1917 will celebrate its hundredth anniversary.

DR. SIMON FLEXNER, director of the Laboratories of the Rockefeller Institute for Medical Research, has been elected foreign associate member of the Paris Academy of Medicine.

PROFESSORS PAUL PAINLEVÉ, of Paris, and Vito Volterra, of Rome, have been elected honorary members of the Royal Institution, London.

DR. ROBERT A. MILLIKAN, professor of physics in the University of Chicago, will hereafter spend three months of each year in research work and lecturing at the Throop College of Technology, at Pasadena, California. This arrangement is similar to that with Dr. A. A. Noyes, professor of physical chemistry at the Massachusetts Institute of Technology, and is made possible by the recently announced gift of $100,000 for physical research.

AT a recent meeting of the corporation of Yale University, a "Yale Research Committee" was appointed to cooperate with the National Research Council. The committee is composed of President Arthur Twining Hadley; Mr. Harry Goodyear Day, of New Haven, and Mr. John Villiers Farwell, of Chicago, representing the corporation of the university; Mr. Edwin Musser Herr, of Pittsburgh, and Mr. William Wallace Nichols, of New York City, representing the alumni; and Professors Treat Baldwin Johnson, Ernest William Brown, James Farley McClelland, Ernest Fox Nichols, Charles-Edward Amory Winslow and Russell Henry Chittenden, chairman, representing the faculties.

AT its last meeting the Rumford Committee of the American Academy of Arts and Sciences made the following appropriations. To Mr. Everett T. King, of Cambridge, $25 in aid of his researches on physical measurements of the color of pigments. To Professor Edward Kremers, of the University of Wisconsin, $300 in aid of his research on the chemical action of light on organic compounds.

DR. H. S. GRINDLEY, professor of animal husbandry in the University of Illinois, was elected president of the American Society of Animal Production at the annual meeting held at the University of Illinois on December 1. Professor John M. Ervard, professor of animal husbandry at Iowa State University, was elected vice-president.

ADMIRAL SIR HENRY JACKSON, K.C.B., F.R.S., first sea lord of the British admiralty, has been appointed to the vacant post of president of the Royal Naval College, Greenwich, and has been succeeded as first sea lord by Admiral Sir John Jellicoe, K.C.B.

Nature states that Dr. Eric Mjöberg, assistant in the entomological department of the Swedish State Museum, has received leave of absence for three years in order to prepare and conduct an expedition to the interior of New Guinea. His intention is to penetrate into the country by aeroplane, taking as his starting point one of the small islands in Geelwink Bay, at the northwest end of the country. Dr.

Mjöberg recently left for America to carry out a lecture tour by which he hopes to raise sums to cover some of the expenses of his expedition.

MAJOR-GENERAL GEORGE W. GOETHALS will speak in the Great Hall of the College of the City of New York on the evening of January 15, on "The Panama Canal." General Goethals was formerly a student of the City College.

PROFESSOR ROBERT A. MILLIKAN, of the University of Chicago, will deliver the William Brewster Clark Memorial lectures at Amherst, probably early in January. The subjects of his four lectures will be: "The Nature of Electricity"; "Brownian Movements and the Kinetic Theory"; "The Insides of the Atom"; "The Nature of Radiation."

DR. E. W. SCRIPTURE recently read to the Pathological Section of the Royal Society of Medicine a communication on registration of speech sounds in the diagnosis of nervous diseases.

MR. F. W. LANCHESTER, the new president of the Junior Institution of Engineers, will deliver his inaugural address to the institution on Monday, December 11, on "Industrial Engineering: Present Position and Post-War Outlook."

ACCORDING to the *Journal* of the American Medical Association the late Professor A. Neisser, the distinguished pathologist, bequeathed his property to the city of Breslau. It is valued at nearly $400,000. He stipulated that his villa with its art treasures be maintained as a museum for contemporaneous art, and further, that the rooms be used in giving high-grade municipal concerts and similar entertainments.

PROFESSOR J. WRIGHTSON, president of the College of Agriculture, Downton (1880–1906), honorary professor of agriculture at the Royal Agricultural College, Cirencester, and professor of agriculture and agricultural chemistry in the Royal College of Science, South Kensington, from 1882 to 1898, died on November 30.

THE committee which was formed with the object of commemorating the late Sir William White's services to the nation in the development of engineering science, and more particularly of naval architecture, has now completed its task. A sum of over $15,000 was raised by private subscriptions, and this amount has been expended as follows: (1) The provision of a fund for providing a Post Graduate Research Scholarship in Naval Architecture of over £100 per annum, tenable for two years; (2) the erection of a Memorial Panel; (3) a donation of one hundred guineas to the Westminster Hospital. The Memorial Panel has been erected in the entrance hall of the Institution of Civil Engineers. The Research Scholarship Fund has been made over to the Council of the Institution of Naval Architects, who will administer the fund and award the scholarship. The latter is to be known as the "Sir William White Research Scholarship in Naval Architecture."

THE *London Times* states that Christmas Island, in the Indian Ocean, 780 sea miles from Singapore, is suffering from the war. Its sole wealth consists in phosphates of lime, and exports decreased from 150,000 tons in 1913 to 25,700 in 1915. Formerly Germany and Austria took large quantities of its phosphates; in 1915 the whole export went to Australia.

UNIVERSITY AND EDUCATIONAL NEWS

AN anonymous gift of $250,000 has been added to the endowment fund of the proposed medical school of the University of Chicago. The total amount of the fund has now reached four million dollars, leaving one million three hundred thousand dollars to be collected.

PURDUE UNIVERSITY is erecting a building of brick and Bedford stone for the school of science. In floor area it will be one of the largest structures on the campus.

THE number of students during the summer semester of 1916 in the Austrian universities is reported to be as follows: Vienna, 3,472; Prague (Czech University), 1,891; Cracow, 1,281; Lemberg, 1,174; Graz, 647; Prague (German University), 638; Innsbruck, 584. The proportion of medical students was highest at Vienna and at Graz (both about 30 per

cent. of the total). At Vienna nearly two fifths of the medical students are women.

THE following promotions have been made at the College of the City of New York: From instructors to be assistant professors: Philosophy, Dr. Howard D. Marsh; mathematics, Dr. Paul H. Linehan; chemistry, Dr. Robert W. Curtis and Dr. William L. Estabrooke. From assistant professorships to associate professorships: Physics, Dr. Joseph G. Coffin.

AT the Iowa State College Dr. Charles A. Mann, of the University of Wisconsin, has been appointed associate professor of chemical engineering to succeed Professor George A. Gabriel, who goes into practical work.

DISCUSSION AND CORRESPONDENCE

A REPLY TO "METHODS OF CRITICISM OF 'SOIL BACTERIA AND PHOSPHATES'"

IN the issue of SCIENCE of November 3, 1916[1] Drs. Hopkins and Whiting have taken occasion to arraign me for having sent to certain editors of agricultural papers a letter headed "Confidential and Not For Publication." They also impugn my motives in writing the letter, for they say it was evidently done to "belittle" the importance of their work, whereas my reason for doing so is explained very fully in the second paragraph of the letter, appended below, and as stated, it was sent to the editors because the work of Hopkins and Whiting was "unfortunately being used by some writers for the purpose of making it appear that the same reaction will take place in the soil in connection with raw rock phosphate to essentially the same extent."

Instead of publishing my letter in full, Drs. Hopkins and Whiting quote only certain parts because of alleged lack of "space," but space was taken, nevertheless, to enter into a lengthy discussion of the validity of the work of Professor Mooers and of Director Thorne on raw rock phosphate, and the intimation was made that I had overlooked some work of the latter. This was seemingly not germane to the real issue, for instead of my having attempted to review their work, I wrote to each of them asking what their results actually showed, and merely quoted, with permission, from their letters. In fact, these letters were of a later date than the literature cited by Hopkins and Whiting in refutation of Mooers' and Thorne's conclusions.

[1] Vol. XLIV., No. 1140, p. 649.

It will be seen, therefore, that the attack by Hopkins and Whiting on these statements resolves itself into an allegation that Professor Mooers and Director Thorne were, in their opinion, incompetent to analyze their own work properly or had misrepresented it to me. This fact I regret exceedingly, for no agricultural investigators in the United States are held in higher esteem by their colleagues than Mooers and Thorne, and hence such allegations can only result in injury to those who make them.

Had my letter been intended as an unfavorable criticism of the work of Hopkins and Whiting, they would most assuredly have been favored with a copy immediately. It was, however, only intended, as stated in the letter itself, as a criticism of the improper use that other persons were making of their results.

I take pleasure in introducing below my letter of July 28, 1916. The reader is asked to note carefully if the letter constitutes an unfavorable criticism of the work of Drs. Hopkins and Whiting or if, as intended, it is merely an appropriate warning to the agricultural press not to draw too far-reaching and improper conclusions from it, for this is the real point at issue.

BOSTON, MASS., July 28, 1916

Confidential and Not For Publication

Dear Sir: My attention has been called within a few days to several articles appearing in the agricultural press which have been inspired by Bulletin No. 190 of the Illinois Agricultural Experiment Station. It appears that Drs. Hopkins and Whiting have experimented with the microorganisms which produce nitrous and nitric acid by the oxidation of ammonia. The work was done in water cultures into which artificially prepared and purified tricalcium phosphate had been introduced. They claim to have shown that the nitrite bacteria caused the lime and phosphoric acid of a highly insoluble phosphate to become soluble.

While this work is of much value as a scientific contribution, it is unfortunately being used by

some writers for the purpose of making it appear that the same reaction will take place in the soil in connection with raw rock phosphate to essentially the same extent. This, however, is not true, as will be explained.

All agricultural soils contain the bases soda, lime, potash and magnesia combined as silicates. Often these silicates are highly basic or, in other words, the proportion of base to the silica is so great that pure water will dissolve appreciable quantities of the bases. Furthermore, if soils have been limed heavily, especially with coarse limestone such as has been recommended by Dr. Hopkins, they are likely to contain in addition some carbonate of lime. The organic acids and the carbonic acid produced in the decomposition of vegetable matter or brought down in the rainfall, including also nitrous and nitric acid, produced as described above, tend to unite in the soil with the most readily attackable bases in the basic silicates and with the lime of the carbonate of lime before they can attack raw rock phosphate effectively. In other words, when nitrous acid is produced in a soil which has been properly limed and has, therefore, been rendered sufficiently basic for the best production of agricultural plants, it is incredible that all or most of it will react upon raw rock phosphate in the soil to the extent that it did in the water cultures used by Hopkins and Whiting in which there was nothing but phosphate which it could attack.

In this connection let me cite Lyon, Fippin and Buckman who, in their recent book on soils, say:

"It has been found, for instance, that calcium carbonate decreases the availability of raw rock phosphate and bone meal."

This action of the calcium carbonate is similar to the action of the highly basic silicates, and it corresponds to the action of the ammonia in stall manure when it is stored under the best conditions for its preservation, for the ammonia combines with the acid so readily as to interfere seriously with its solvent action on raw rock phosphate. In fact, it was probably because of this that Hartwell and Pember in Rhode Island and Hart and his coworkers in Wisconsin failed to demonstrate that composting manure and raw rock phosphate made the latter soluble or highly available to plants.

In this connection note what Director Thorne, of the Ohio Agricultural Experiment Station, says:

"Where we have used floats as a reenforcement of manure on this farm alongside of acid phosphate, the acid phosphate has given us a slightly larger net gain in the average of the 18 years' work, and a decidedly larger gain during the last half of this period—a result the opposite of what we expected when we started the experiment. The floats and the acid phosphate being used in the same quantity, or 40 pounds per ton of manure, we expected that the larger accumulation of phosphorus in the soil due to the floats would finally result in the floats exceeding the acid phosphates in total and net gain, but this has not happened."

If there were such a tremendous solvent effect of raw rock phosphate in the soil as some writers would make us believe after they have read and commented upon this bulletin, it is surprising that the Tennessee Agricultural Experiment Station should report as it does on raw rock phosphate, for Professor Mooers says:

"In reply to your recent inquiry will say that we have not published anything recently with regard to the comparative values of acid phosphate and rock phosphate, but we have conducted experiments with these two materials on various types of soil in different parts of the state for the past ten years. The results of our experimental work do not allow us to recommend raw rock phosphate for general use. In fact, we discourage its use anywhere in the state and recommend acid phosphate as the most profitable of all phosphates. In some of our experimental work the raw rock has given profitable returns, but in no instance clearly equal to acid phosphate. In all of the experiments the two materials have been used in approximately equal money values and in connection with green manuring, which is supposed by some to increase appreciably the availability of rock phosphate.

"In some of our experiments conducted on soils especially poor in phosphoric acid the returns from the rock phosphate have been very meager and not at all comparable with those from acid phosphate. For us to give the preference to rock phosphate would be to ignore all of our experimental data. I may add that when the land is limed the acid phosphate shows considerably greater superiority over the rock phosphate than where unlimed."

The work of Hopkins and Whiting was done on an especially soluble, artificial tricalcium phosphate, in a solution in a glass vessel kept at a high temperature where the acid could attack nothing but the phosphate, whereas the farmer has to deal with a soil containing far more readily decomposable silicates and carbonates, substances upon which the acid can react to a very large extent before it has a chance to attack the less soluble raw phosphate rock.

Let us appreciate this work of Hopkins and Whiting as an interesting contribution to the study of nitrification, but let us not draw too far-reaching and improper conclusions from it which are only partially applicable to field conditions.

In fact Hopkins and Whiting say in this Bulletin that:

"The addition of limestone with the insoluble phosphates prevents the detection of soluble phosphates."

They also say that:

"The nitrous acid produced may act upon compounds of iron, aluminum, potassium, sodium or magnesium which occur in soils, or it may act upon tricalcium phosphate, calcium silicate or calcium carbonate, if present."

In their hope of confining the solvent action of the nitrous acid as fully as possible to the raw phosphate rock, Hopkins has recommended that the phosphate be turned under in intimate contact with organic matter, yet when one realizes the even closer contact of the many soil particles with the organic matter at the same time, it will be obviously impossible for the nitrous acid to attack wholly or even chiefly the raw rock phosphate. This idea is fully supported by Thorne's practical field tests in Ohio, by the work of Mooers and others in Tennessee, and by the collective evidence of practically all of the agricultural chemists in the United States and Europe.

H. J. WHEELER

I gladly leave the judgment of the ethical and scientific questions involved to the impartial court of my colleagues at home and abroad.

H. J. WHEELER

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1916 OR 1816?

THE following announcement has appeared in the *Washington Times*, Wednesday, December 20, 1916:

PHRENOLOGIST TO SPEAK

Professor G. W. Savory, a graduate of the Fowler School of Phrenology of New York, will address the Enosinian Literary Society of George Washington University on the evening of January 15. His subject will be "Brains—How to Know and Handle Them." The lecture will be given in the assembly hall of the Arts and Sciences Department building, 2023 G street northwest.

Comments would seem superfluous.

A. HRDLIČKA

QUOTATIONS

SCIENCE IN GERMANY FROM AN ENGLISH VIEWPOINT

GERMANY has been held up to us so long as the model in all matters of state organization that most English students of institutions will read with surprise the letter published in another column, which has been addressed by the Committee of the Institution of German Engineers to Herr von Bethmann Hollweg in favor of the opening of the German civil service to men of scientific training. To-day the higher branches of the German civil service are reserved for lawyers, and are not open to graduates of the technical high schools. The evil of this system has long been felt in Germany. Ten years ago the German government admitted that the higher branches of their civil service were not manned in accordance with the requirements of the time. The training of those officials, even since the reforms of 1906, consist of a secondary-school course with a strong bias towards the humanities, followed by a short university course almost exclusively composed of legal subjects. The ordinary law course is the higher civil service course. Whatever a student's inclination or tendency may be, the legal training is a condition precedent to a civil service career. "Civil servants," the chancellor is told with pathetic force, "are called upon to deal with problems the expert solution of which calls for just the type of mental equipment that is provided by the technical high schools. . . . The forcible exclusion of the intellect that is available amongst these circles from participation in the higher civil service constitutes a waste of the intellectual powers of our nation."

The loss of the German nation under such an absurd system is not our concern; the point that we are interested in is that this nation, which claims to lead the world in administrative efficiency is in this instance, at least as dissatisfied with its achievements in the most important part of the organization of a nation as even England herself. Of course all the world knows now that Germany has long eked out her various weaknesses in administration by trumpetings that have brought down with a run the Jericho walls of foreign

prejudice. She has so long and so loudly insisted that she leads the world in all organization and administration that it is a shock to find that her civil service is admittedly inefficient. It is already well known that her social science, as reflected in the infant death-rate, is inefficient. Various branches of her educational system are very weak and ill-organized. We are beginning at last to realize that German face-values are not always true values. But this, though entertaining, is not necessarily comforting to us. Is our own Home Civil Service, devoted though it is, selected on a system that is calculated to secure men who have, as part of their outfit, the scientific method of thought? We do not want pure or applied scientists for our service any more than the Germans want lawyers. We believe that the German engineers are wrong in the system that they would substitute for the legal system. What is needed for an efficient civil service is a class of men and women trained to think, to see and to foresee.—*London Times Educational Supplement.*

SCIENTIFIC BOOKS

Soils, Their Properties and Management. By T. LYTTLETON LYON, Ph.D., Professor of Soil Technology; ELMER O. FIPPIN, B.S.A., Extension Professor of Soil Technology; and HARRY O. BUCKMAN, Ph.D., Assistant Professor of Soil Technology, all of Cornell University. New York, The Macmillan Company. 764 pages.

This is a very complete text on soil technology, as can be seen from the following chapter heads: I. Some General Considerations; II. Soil-Forming Processes; III. The Geological Classification of Soils; IV. Geological Classification of Soils (Continued); V. Climatic and Geochemical Relationships of Soils; VI. The Soil Particle; VII. Some Physical Properties of the Soil; VIII. The Organic Matter of the Soil; IX. The Colloidal Matter of Soils; X. Soil Structure; XI. The Forms of Soil Water and their Movement; XII. The Water of the Soil in its Relation to Plants; XIII. The Control of Soil Moisture; XIV. Soil Heat; XV. Availability of Plant Nutrients as Determined by Chemical Analysis; XVI. The Absorptive Properties of Soils; XVII. Acid or Sour Soils; XVIII. Alkali Salts; XIX. Absorption of Nutritive Salts by Agricultural Plants; XX. Organisms in the Soil; XXI. The Nitrogen Cycle; XXII. The Soil Air; XXIII. Commercial Fertilizers; XXIV. Soil Amendments; XXV. Fertilizer Practise; XXVI. Farm Manures; XXVII. Green Manures; XXVIII. Land Drainage; XXIX. Tillage; XXX. Irrigation and Dry Farming; XXXI. The Soil Survey.

Particular attention should be drawn to the all too brief chapters on the organic matter and the colloidal matter of soils, both of which are admirably done. The discussion is clear and to the point. Too often organic matter is hazily treated, and colloids neglected entirely. As a book of reference for students of soils this text is exceptionally good, not only for the subject-matter itself, but also for the profuse bibliography. But as a text for a general class in soil technology it is somewhat too comprehensive, and the subject-matter not sufficiently coordinated. The various phases of soil study are taken up as separate subjects and not treated as parts of a whole. Although the soil is a very complex material, its various functions work together and should be studied in their interrelationships.

There are a few corrections to be made. The word "protein" is better than "proteid," page 12, line 7. The formula for kaolinite on page 22 does not agree with the formula on page 9. The latter is correct. On page 128, line 14, "proteosis" should be "proteoses." There is too frequent use of the phrase "and the like" after a series of names. It is as bad as too many "and so forths."

The typography and binding are excellent. Such illustrations as are given are good, but a text should be more profusely illustrated for the average student. Good pictures well chosen add very greatly to the pedagogic value of a text-book. All things considered, however, the authors are to be congratulated on producing a book so complete, so accurate, so well written, and so useful to all students of the soil.

C. W. STODDART

STATE COLLEGE, PA.

Organic Agricultural Chemistry (The Chemistry of Plants and Animals). A text-book of general agricultural chemistry or elementary bio-chemistry for use in colleges. By JOSEPH SCUDDER CHAMBERLAIN, Ph.D., Professor of Organic and Agricultural Chemistry in the Massachusetts Agricultural College. New York, The Macmillan Company, 1916. 319 pages.

In following out certain modern ideas that science can be applied from the beginning and not lose any of its scientific value, this text comes as a distinct change from the usual books on the subject of organic and agricultural chemistry. It starts in with a brief description of systematic organic chemistry, but keeps in mind all the time that the compounds described have an agricultural value. Then follows a section on physiological chemistry dealing first with animals and then with plants. Finally there is a section on crops, foods and feeding which presents "the chemical basis for the valuation of animal foods but without entering into the discussion of the practical operation and results of animal feeding."

The following are the chapter headings: Section I. *Systematic.* Chapter I. Hydrocarbons; II. Substitution Products of the Hydrocarbons; III. Oxidation Products of Alcohols; IV. Derivatives of Alcohols and Acids; V. Mixed Compounds; VI. Amino-Acids, Proteins, Urea, Uric Acid; VII. Carbohydrates. Section II. *Physiological.* Chapter VIII. Enzymes and Enzymatic Action; IX. Composition of Plants and Animals; X. The Living Cell and Its Food; XI. Animal Food and Nutrition; Digestion and Absorption; XII. Animal Food and Nutrition; Metabolism; XIII. Milk, Blood and Urine; XIV. Plant Physiology. Section III. *Crops, Foods and Feeding.* Chapter XV. Occurrence and Uses of Important Constituents in Agricultural Plants; XVI. Occurrence and Uses of Important Constituents in Agricultural Plants (Continued); XVII. Animal Foods and Feeding.

One criticism to be made is of the statement occurring now and then that certain processes can not be explained here, or that it is unnecessary to give the proof for some reaction. In an elementary text it is not wise to make such statements. It is far better to give as many of the facts as are desirable or necessary for the case in point and make no apologies. Another fault to be found is that there are no illustrations. All texts should be generously illustrated with good pictures if the average student is to make the best use of the book.

The idea of using only those compounds occurring in a study of agricultural chemistry is well worked out, and the student is carried rapidly from simple to complex forms without any loss of time and without any loss of the unity or coordination of systematic organic chemistry. This section shows very well how such a subject can be practically applied without losing any of the pure science. In the section on physiological chemistry the action of enzymes and the chemistry of the cell are made very plain. Crops are discussed briefly but efficiently, and the question of nutrition treated with just enough detail to acquaint the student with the underlying principles.

The book is well printed and neatly bound. It is a volume to be recommended to those who desire a condensed treatment of biochemistry, being thoroughly scientific and yet practical and interesting.

C. W. STODDART

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THE UNITED STATES GEOLOGICAL SURVEY MAPS

THE thirty-seventh annual report of the U. S. Geological Survey states that the project of covering the 3,000,000 square miles of the United States with accurate topographic surveys was definitely adopted by the federal government in 1882, and the work is even now less than half completed. The standards of accuracy and refinement in topographic surveying have been constantly raised by the topographic engineers, with the view of meeting adequately every use to which the resulting maps can be put. The law provides for the sale of the United States Geological Survey maps at the

cost of printing, a charge that must be considered merely nominal when it is realized that the cost of an edition of the printed map may be only a small percentage of the cost of surveying the area it represents. The government itself is making a large and increasing use of these topographic maps, but the expenditure of public funds for these surveys is otherwise fully warranted only as the public uses the maps. To promote this use, the survey has recently given more attention to the wider distribution of the maps.

The distribution of a government map is largely a problem of publicity, though the necessity of adopting commercial business methods in handling orders for the maps when once a demand is created must not be overlooked. In informing the public of the existence of authoritative maps published by the federal government a special effort is now made to reach the communities in each area covered by a map, and to this end every map as issued is brought to the attention of the local and state press, as well as of postmasters and school-teachers.

Other methods of promoting wider distribution involve the cooperation of boy-scout masters, schoolboys and hotel managers, as well as of a large number of bookstores as local agents.

Within the last year the most helpful publicity has been gained through the voluntary cooperation of several press services and magazines of large circulation, in connection with their policy of bringing the people into closer touch with the work and publications of the federal government. The publication in one magazine of a brief statement regarding the Geological Survey's maps resulted within a month in orders for 550 maps and thousands of inquiries for the state indexes that show the areas already mapped.

The periods of maximum demand for these governments maps are the beginning of the vacation period and the beginning of the school year. The larger use of topographic maps in 1915–16, both in the open and in the classroom, is a gratifying index of the popular benefit already resulting from the increase in the work of publicity.

A NEW INSECT ENEMY OF THE PEACH

An insect destructive to the peach and kindred fruits, believed to be new in the United States, has been discovered by entomologists of the U. S. Department of Agriculture in the District of Columbia and its environs. This insect, which in its adult form is a brownish moth and in its larval stage a small white and pink caterpillar, attacks both the tender shoots and fruit, causing serious losses.

Because of the habits of the worm, the usual control measures, such as spraying with certain arsenates, will probably not be effective. The smooth young shoots, owing to their rapid growth, are protected by the poison solution for only a very short time after the spray is applied, and hence it is almost impossible to poison them. The entomologists of the department who have been investigating the pest, will continue to study it in the hope of developing control measures.

The insect, known to science as *Laspeyresia molesta*, is believed to have been introduced from Japan. So far as the department's entomologists know, it has not been found in America other than in the District of Columbia and in the adjoining territory in Maryland and Virginia. The specialists are desirous of knowing if the insect has attacked peach, plum or cherry trees elsewhere in the United States.

The presence of the insect can best be determined in most cases by the nature of its injury to peach trees. It bores into practically every tender twig and causes new shoots to push out from lateral buds. These are attacked in turn, the abnormal stimulation of lateral growth producing a much branched and bushy plant. A copious flow of gum from the twig-ends often follows the attacks of the caterpillars.

In attacking fruit the young caterpillars generally eat through the skin at or near the point of attachment of the fruit stem. The larva, as it grows, makes its way to the pit, where it feeds on the flesh, which soon becomes much discolored and more or less slimy. Larvæ entering at the side of the fruit are more likely to eat out pockets or cavities in the flesh. The full-grown caterpillar spins a whit-